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THE NATIONAL ACADEMY OF SCIENCES

ABSTRACTS OF PAPERS PRESENTED AT THE ANNUAL MEETING[1]

A hypothesis as to the origin of cosmic rays and the experimental testing of it in India and elsewhere (evening lecture): R. A. MILLIKAN, H. V. NEHER and W. H. PICKERING. The hypothesis here adopted as to the mode of origin of the cosmic rays makes possible the prediction of five definite cosmic-ray bands, each of which should reach the earth in a particular latitude, and of four plateaus of unchanging cosmic-ray intensity, these plateaus being delimited by the latitudes of entrance of the successive bands. The hypothesis rendering possible these predictions rests upon five major discoveries made by the workers in the Norman Bridge Laboratory of Physics at the California Institute of Technology at Pasadena. These discoveries are (1) that more than 60 per cent. of all incoming cosmic-ray energy is of the nature of *electron bullets* each of energy between 2 billion electron-volts and 15 billion electron-volts; (2) Neddermeyer and Anderson's discovery of the production by nuclear impacts within the atmosphere of mesotrons which carry the energy farther down than incoming electrons alone could do; (3) Bowen's two remarkable discoveries: first, that atoms, when out in interstellar space, are able to undergo atomic transformations forbidden to them within the stars, and second, (4) that in ring-nebulae, trillions of miles away from the exciting star and therefore presumably reflecting conditions in interstellar space there are five of the atoms, namely, helium, carbon, nitrogen, oxygen and silicon, each of which is more than ten times more abundant than any other atom save hydrogen (which must be excluded from measurable cosmic-ray effects because of the smallness of its rest-mass energy), and (5) Lauritsen and Fowler's discovery in the Kellogg Radiation Laboratory that a part at least of the rest-mass energy of an atom has the power under suitable conditions of transforming itself directly into the creation of an "electron-pair." The hypothesis made in view of these five discoveries is that, while the evolution of energy by the stars is maintained, as Bethe has recently shown, by the *partial* transformation, within the stars of the rest-mass energy of hydrogen into radiant energy through

[1] Held in the building of the National Academy of Sciences, Washington, April 28 and 29.

the building of helium, carbon and other atoms out of hydrogen, and the release through this process of the so-called "packing-fraction" energy, the energy of cosmic rays on the other hand is maintained, by the occasional *complete* transformation in interstellar space of the rest-mass energy of the atoms of helium, carbon, nitrogen, oxygen and silicon (and even heavier aggregates), into cosmic rays, each such event presumably creating an electron pair, though an occasional photon pair, or neutron pair, or even proton pair for sufficiently high energies, need not *necessarily* be excluded. The foregoing hypothesis requires that the cosmic rays of measurable energy reveal a spectral distribution of five distinct, definitely measurable bands as follows: (1) a band of rays each having an energy of 1.9 billion electron-volts produced by the annihilation, or complete transformation, in interstellar space of the rest-mass energy of the helium atom; (2) a carbon-atom-annihilation band of energy 5.6 billion electron-volts (b.e.v.); (3) a nitrogen atom band of energy 6.6 b.e.v.; (4) an oxygen atom band of energy 7.5 b.e.v. and (5) a silicon atom band of energy 13.2 b.e.v. The hypothesis requires further that there should be in India, for vertically incoming rays, between the magnetic equator and magnetic latitude about 20 degrees N. a plateau of unchanging cosmic-ray intensity with latitude; it requires another such plateau between the latitudes of entrance and the bands due to the silicon and oxygen atoms; it requires a third such plateau between the great band produced by the annihilation of the carbon, nitrogen and oxygen atoms, and that due to the annihilation of helium; and finally it requires a fourth such plateau north of Bismarck, North Dakota, where as the observer goes northward the helium band should first be able to get vertically through the blocking effect of the earth's magnetic field and should then be able to enter the earth in full strength at all more northerly latitudes. The experimental evidence that has been so far obtained in India and elsewhere for the existence of these five bands and four plateaus may be thus summarized. The evidence seems to be excellent for the existence of the silicon band, the joint nitrogen-oxygen band, the carbon band and the helium band. Also all of these bands are found, roughly at least, in the predicted latitudes and of right order of intensities. The evidence also appears to be good for the existence of the four above mentioned plateaus of constant cosmic-ray intensity. Further experiments are being made to see whether better designed apparatus will render the nature of the evidence better or worse for the hypothesis and new experiments in Mexico and the United States are planned for the coming summer. This comparison of prediction and experiment has been made possible largely through the generous support of the investigation by the Carnegie Corporation of New York and the Carnegie Institution of Washington. The success of the work in India was made possible by the extraordinarily generous and complete cooperation of the British Indian Meteorological Service.

Transformations of isothermal families: EDWARD KASNER.

Distribution of mass in the spiral nebulae Messier 31 and 33: A. B. WYSE and N. U. MAYALL (introduced by W. H. Wright). Recent spectroscopic observations of Messier 31 and 33, by one of the authors and his associates, have established the general character of their rotational motions. So far as is known, no other objects of the kind have been sufficiently investigated to yield data competent to indicate the mass distribution. The observational results proved surprising in two respects: first, there is a minimum of rotational velocity, for Messier 31 at least, at a relatively short distance from the center, beyond which there is again an increase; second, the velocities in both nebulae increase outwards to unexpectedly large distances from the center. The results are so little in accord with earlier conceptions of dynamical conditions in the spiral nebulae that it has seemed worth while to inquire whether the observed velocities could be explained on the basis of some hypothetical distribution of material in the two systems. In an attempt to reduce the inquiry to the simplest practicable terms, the mathematical relation between mass distribution and rotational motion has been investigated for non-homogeneous thin disks. Applications to Messier 31 and 33 yield mass distributions that account satisfactorily for the observed velocities of rotation. The results for both spirals indicate only a very slight tendency for the mass to be concentrated toward the center. The high central condensation of mass hitherto commonly ascribed to the Galaxy has been examined, and has been found to be not a necessary consequence of observations of galactic rotation. Comparison of the densities and the rotational velocities in the two spirals with those in the solar neighborhood suggests that the sun may be situated in the outermost parts of the Galaxy, well beyond the main body of the system.

Direction of rotation of spiral nebulae: EDWIN HUBBLE and NICHOLAS U. MAYALL. The paper presents the first unambiguous determination of the direction of rotation of a spiral nebula. The nebula, NGC 3190, an early type, normal spiral, trails its arms as it rotates. The direction of rotation has been an unsolved problem of fundamental importance for theories of the origin and development of spiral structure. The solution involves the determination of the spectrographic rotation of nebulae in which the direction of the spiral patterns can be detected and, at the same time, the sense of the tilt is known (near sides can be distinguished from the far sides). A survey of the 1,000 brightest nebulae in the northern sky has furnished only one system, NGC 3190, which fulfils the last two requirements. The sense of the spectrographic rotation in this nebula has now been observed, and it is found that the spiral trails its arms. In five other spirals, for which spectrographic rotations are available, the direction of rotation is correlated with asymmetry of obscuration. If the sharper and heavier absorption features indicate the near sides, these spirals trail their arms—and *vice versa*. The unambiguous result for NGC 3190 is believed to interpret the correlation, and consequently, suggests that all spirals trail their arms as they rotate.

A Solar Prominence in Three Dimensions: ROBERT R. MCMATH (introduced by Heber D. Curtis). On our solar motion picture films we measure the successive images of formations in solar prominences in two directions at

right angles. The plane in which these projected motions are measured is perpendicular to the line of sight from us to the sun and is called the *XY* plane. These results are not sufficient to determine the actual motion and speed of a prominence detail in space; for such a purpose we need measures of distances and speeds in three dimensions. The new Stone spectroheliograph of the McMath-Hulbert Observatory gives us the concurrent speeds at which a formation is moving directly toward to directly away from us; that is, a radial velocity, or *Z* speed, in our line of sight. Armed with measures of distances and speeds in three mutually perpendicular directions, we are able to determine the actual movement in space and the velocity of that motion. A study of the space motions of six knots which traversed fairly persistent streamer paths forms the observational basis of this preliminary paper. The prominence in which the knots were located was under observation for several consecutive days, and a disk spectroheliogram of the prominence and an accompanying sunspot was secured after the spot and prominence had rotated into the field of view. This combination of events enabled us to build a model, based on the observationl data combined with some judgment, which is considered to be a fair representation of the actual space form of the prominence and its streamers. Portions of several of the motions found resemble free fall in a partially compensated gravitational field. These new space motions show clearly that the velocities in the knots included in this investigation are not uniform, and that they are subjected to acceleration or deceleration, depending upon the distribution of the several forces acting in their respective force fields.

Design and characteristics of a magnet for cosmic-ray cloud-chamber studies: ROBERT B. BRODE (introduced by J. A. Fleming). The study of cosmic-ray mesotrons requires a magnet that will appreciably deflect particles of an energy of 10^{10} electron-volts. The operation of a Wilson cloud-chamber requires long periods of operation at constant temperature. The design and dimensions of a magnet for this purpose were determined by studies on small models. In the final magnet 5,300 pounds of steel were used in casting the yokes and 2,700 pounds of copper wire were used in the coils. To reduce the saturation in the steel, the poles were coned from a diameter of 18 inches to a diameter of 12 inches in ten inches distance. The front pole has a conical hole in it that permits the cloud-chamber to be photographed directly without the use of mirrors. The hollow center of the front pole throws flux from the center towards the outside so that the flux-density as measured in the illuminated plane of a cloud-chamber 30 cm in diameter is constant to within 5 per cent. The coils were wound with No. 6 square double-glass-covered copper wire. The turns were cemented together with an air-drying binder. Cooling is provided by the circulation of water in four layers of copper tubing in each coil. Six kilowatts obtained from the direct-current supply system produced an average field of over 9,000 gauss. In spite of the large hole in the front pole the equivalent air-gap of the magnet is only 14 cm.

Studies of mesotron absorption and production in a large Wilson chamber: T. H. JOHNSON (introduced by F. E. Wright). Studies bearing upon the production and disappearance of mesotrons have been made by R. P. Shutt and the writer in a large Wilson chamber containing three lead plates. Since the observational data consist of the directions and the densities of the tracks before and after the traversals, whereas the processes of interest occur within the lead plates and are not observed directly, the method is essentially statistical. A pair of mesons, originating in a lead plate with no visible particle entering above, would be evidence of the production of mesons by gamma rays, but no events of this nature have been observed, although we would have expected many if the hypothesis were tenable that gamma rays in the upper atmosphere are the principal producers of mesons. The ratio of the number of slow mesons with dense tracks in the gas to the number stopped by the lead plates agrees with expectations based upon the ionization losses and gives no indication of other absorptive processes. The scattering of the mesons by the lead is also that predicted for the coulomb forces and gives no indication of extraordinary forces acting between mesons and lead nuclei. If mesons are being stopped by processes other than ionization, the statistics obtained from 10,000 tracks traversing the lead are insufficient to put such processes in evidence, and it will be necessary to adopt a technique in which the individual events are observed directly in a dense gas. For this purpose we are constructing a cloud chamber 12 inches in diameter to operate at a pressure of 200 to 300 atmospheres. This chamber will be immersed in a transparent oil contained in a thick-walled steel tank. Photographs will be made through a thick glass window the size of the camera lens, and the chamber will be illuminated by arcs placed inside the tank. When filled with argon this chamber will have a cosmic-ray stopping power equivalent to 7 cms of water or nearly 1 cm of lead.

Diffraction gratings and replicas far astrophysical research: R. W. WOOD. An account was given of improvements made in the construction of large reflecting gratings ruled on an aluminum surface which have resulted in their adoption in place of prisms in the large spectrograph of the 100-inch telescope at Mt. Wilson and elsewhere. A report of the excellent results obtained with these gratings, by Dr. Adams, the director of the observatory, appears in the January number of the *Astrophysical Journal*. Great advances have also been made in the preparation of large transparent diffraction gratings (replicas) for astrophysical research. Six replica gratings, each measuring $4 \times 6\frac{1}{4}$ inches, with 800 lines to the inch, throwing about 90 per cent. of the light into the first order spectrum, were made and mounted between thin glass plates figured by Taylor Bethel, of Southport, Long Island. These were mounted in adjustable aluminum frames over the 18-inch Schmidt star camera at Mt. Palomar by Dr. Zwicky, and excellent results obtained. Nine absorption lines of the hydrogen series appeared in the spectrum of Sirius made with a very short exposure. No spectra of

higher order appeared, and the central image was a faint narrow line. These gratings covered only 60 per cent. of the aperture of the Schmidt. Two glass discs 18 inches in diameter are now in preparation, and similar replicas will be mounted between them, covering 98 per cent. of the camera's aperture. Dr. Zwicky is of the opinion that a wide field of investigation on the classification of the spectra of very faint stars will open up by the use of this arrangement. The replicas have high dispersion and give great intensity in the infra red, the calcium line at 8,542 coming out strong. Last year, with a replica of 7,500 lines to the inch mounted over a 3-inch Schmidt camera of only 5 inches focus, at the Mt. Wilson, I obtained an excellent spectrum of Arcturus in 15 seconds and one of the ring nebula in Lyra in 10 minutes. A new combination was described for determining the velocities of faint stars. Two replica gratings are mounted on two prisms, so oriented as to yield two spectra of each star in coincidence one above the other but facing in opposite directions, the violet portions being side by side. The spectra are pushed together or pulled apart according as the star is approaching or receding, and the velocity determined by the shift of the lines. This has been tested at the Harvard Observatory with good results.

Protons as primary cosmic rays: ARTHUR H. COMPTON and MARCEL SCHEIN. Starting with the hypothesis that the primary cosmic ray particles entering the atmosphere consist solely of protons, the consequences are compared with the major cosmic ray phenomena. The hypothesis is strongly supported by the new observation, made by the Chicago group, that the incoming primaries are mesotron-producing ionizing particles which, unlike high energy electrons, do not excite showers in lead. We assume that the protons spend most of their energy-producing mesotrons with a wide energy distribution and that this occurs mostly within the first 5 per cent. of the atmosphere. The slower mesotrons, by disintegration into electrons and photons, are progenitors of the soft component, while the faster mesotrons may persist to the ground, appearing as the hard component. Good agreement, at least roughly quantitative, has thus been obtained with the observed depth-ionization curve, the latitude effect at different altitudes, and, as T. H. Johnson has previously shown, with the directional asymmetry of the penetrating component. Our interpretation of the low asymmetry of the soft component would follow that suggested by Swann. The evidence thus strongly indicates protons as the major, perhaps the only, component of primary cosmic rays.

Water masses and currents of the North Pacific Ocean:[1] H. U. SVERDRUP. The waters of the North Pacific can be considered as made up of five distinctly different water masses above a uniform deep water and covered by a thin surface layer. Perfect static equilibrium does not exist because the density of the water varies from one region of the ocean to the other, and water masses of different density can not remain next to each other unless currents are present. The equilibrium is therefore not static but dynamic, and is maintained by the prevailing currents and the changes to which the moving waters are subjected by contact with the atmosphere and by processes of mixing. The major currents of the North Pacific have the character of a series of clockwise circulations. The north and south equatorial currents flow to the west between the Equator and latitudes 20° to 25° N, and imbedded between them in latitudes 5° to 10° N the equatorial counter current flows east. Part of the water of the north equatorial current bends north when reaching the Asiatic islands and flows along the coast of Japan as the warm Kuroshio. In latitude 35° N the current turns east, one branch continuing due east and another taking a more northerly course. The water of the former turns gradually south, the greater part joining the north equatorial current to the west of the Hawaiian Islands and completing a clockwise circulation. To the east of the Hawaiian Islands and extending to about 400 miles from the American west coast is a smaller clockwise whirl which is in part linked with the bigger one to the west. The waters of the northern branch of the Kuroshio mix with the waters of the cold Oyashio and continue to the east as the cold subarctic current of the North Pacific which flows between the south coast of the Aleutian Islands and latitude 42° N. When reaching the American west coast, part of this water bends north into the Gulf of Alaska and part bends south, flowing as the cold California Current which can be traced to about latitude 25° N. The waters of the California Current mix with equatorial water and complete the largest circuit in the North Pacific as they join the west-flowing north equatorial current.

[1] Contributions of the Scripps Institution of Oceanography, New Series, No. 129.

The use of lethals to separate the components of heterocaryotic races of Neurospora: B. O. DODGE. The four-spored races of the *Neurospora tetrasperma* type have, as a rule, originally two nuclei of opposite sex in each ascospore. To use such forms in genetic work the components must be separated either by using dwarf ascospores or the minute conidia. *N. Toroi* seldom forms dwarf ascospores and the unisexual components less rarely become separated in vegetative growth. To overcome this handicap, the dominant lethal E has been used to induce the formation of many eight-spored asci in culture so that the ascospores are unisexual instead of bisexual. The number of unisexual races available for breeding work is, therefore, unlimited and they are readily obtained by growing the races into which the dominant lethal has been introduced on certain kinds of media. The recessive lethal *d*, which acts to suppress the production of conidia in the haploid vegetative condition, apparently is unable to function strongly as a lethal in the absence of the proper amount of agar. A sex-linked character which is manifested by a difference in the coloration of the mycelia and conidia of races of opposite sex is readily detected when they are grown on media with the proper amounts of Difco agar.

Genes in Datura which induce morphological effects resembling those due to environment: ALBERT F. BLAKESLEE and A. G. AVERY. Induced and spontaneous gene mutants which resemble the morphological effects brought

about by environmental factors are not infrequent in Datura. Thus two divisions of the pistil are characteristic of the genus Datura. An occasional tricarpel fruit, however, may be formed on a plant which is otherwise dicarpel. Such abnormal fruits are apparently due to environmental factors since the character is not inherited. However, a spontaneous mutation has arisen in our cultures which has given rise to a pure-breeding tricarpel race. Similarly, Datura is normally diforked, with an occasional plant which is triforked—apparently on account of environmental factors. However, a pure-breeding race has been found in nature which is normally triforked. Datura is susceptible to a number of virus diseases which produce characteristic changes in the plants affected. Some of the gene mutants show similar changes in appearance. One pure-breeding mutant type which is due to a recessive gene is of especial interest since it closely resembles in appearance the *quercina* virus disease. Both the *quercina* virus and the *quercina*-like gene cause the elimination of spines from the capsule, the division of the tubular corolla into individual petals and the production of narrow, eroded leaves. The *quercina* disease can be transmitted to a healthy plant by grafting, but this is not true of the *quercina*-like mutant type. It is apparent that genes and environmental factors may bring about similar end results through their effects upon the developmental processes in the plant. The similarity of the effects of certain genes and viruses suggests that they alter the internal environment in similar manner. Both virus and the determiners of heredity exist as discrete self-perpetuating particles, and both are subject to induced mutations. The similarity of their action supports the suggestion that the chief difference between the two may lie in the fact that the virus particle is free and hence capable of undergoing uncontrolled reproduction, whereas the gene is confined to a specific locus within the chromosome and its propagation is limited by the mechanism of heredity. The facts give support to the suggestion of an evolutionary relationship between viruses and genes.

Growth regulation of plants and formative effects induced with β-naphthoxyacetic acid: P. W. ZIMMERMAN (introduced by B. O. Dodge). Many growth substances have in common the capacity to induce similar responses in plants; that is, cause cell elongation, increase cell division and induce adventitious roots. There are, however, many qualitative differences in the capacity of chemically similar compounds to induce physiological responses. For example, β-naphthoxyacetic acid and its derivatives modify the new organs (leaves, stems, flowers and fruit) which are formed after the growing points are treated with the substance. The pattern and venation of compound leaves become modified, appearing frenched and fasciated. Leaflets frequently grow together on portions of compound leaves. Compound types sometimes become simple leaves and again doubly compound. Both the pattern and opaqueness of veins are modified. Veins of modified leaves show clearing, which is usually characteristic of virus-diseased plants. Tobacco plants sprayed at the tip with a solution (300 mg./l.) of β-naphthoxyacetic acid grow taller and flower ahead of controls. Treated delphinium plants also flower ahead of controls. Unless plants are retreated at intervals they recover and again produce normal leaves and flowers. Parthenocarpic development of tomato fruit is induced when flowers or well-developed buds are sprayed with emulsions or solutions of naphthoxyacetic acid. The ovaries often enlarge before the flowers open, eventually breaking through on one side of the calyx tube. The floral parts—petals, stamens and pistils—persist for an abnormally long time during the parthenocarpic development. In some cases both petals and stamens remain in good condition for thirty days whereas controls wither within three days after the flowers open. Compared with other growth substances naphthoxyacetic acid has several advantages for practical production of seedless tomatoes and possibly of other fruits. The results of these experiments show that formative effects can be induced under the influence of a known chemical compound. This may help to explain some of the observed phenomena in nature under the influence of natural hormones.

The relative position of cell walls in developing plant tissues: EDMUND W. SINNOTT and ROBERT BLOCH. In growing plant tissues the position of new cell walls is not fortuitous but has a definite relation to the position of walls already present in adjacent tissues. There are two main types of relative wall position: (1) Most commonly, a new wall avoids intersecting an old one at a point directly opposite the point of insertion of an adjacent partition wall, so that the walls alternate or "break joints" and only three meet at a point. This type can best be studied in tissues where the cells are in parallel rows and all new walls are in one plane. In such cases the degree of avoidance can be shown graphically. (2) In certain tissues just the reverse condition occurs, a new wall being formed directly opposite the point of insertion of a previous one, so that four walls meet at a point. This is frequently found in the cortex of roots, in polyderm and in normal and regenerative periderm. Developmental studies show that the factors determining the position of the wall do so very early by controlling the position of the plate of cytoplasmic strands, or phragmosome, long before the wall itself is laid down. For this and other reasons the liquid film hypothesis, commonly invoked to explain the alternating type of wall position, is regarded as inadequate. The opposite type of wall position seems to be related to local changes in the character of the mother-cell wall. Aside from their bearing on the general appearance of plant tissues, these facts are of significance in problems dealing with tissue cohesion, the production of aerenchyma and the number of faces of contact between cells.

Biotin and the growth of Fusarium avenaceum: WILLIAM J. ROBBINS. A strain of *Fusarium avenaceum* obtained from South America does not grow in a solution of mineral salts and sugar but grows on the same solution solidified with agar. The beneficial effect of agar on the growth of this organism is chiefly because of biotin (vitamin H) present in the agar. Purification of the agar by extraction with aqueous pyridine removes the biotin

and makes the agar ineffective in permitting growth of the fungus. The amount of biotin present varies with the sample of agar but approximates 0.1 microgram per gram in some samples. This is about one third the amount in dried egg yolk. Agar was more beneficial than could be accounted for by its biotin content. A beneficial effect of 0.001 microgram of pure biotin (obtained from Dr. Vincent du Vigneaud) on the growth of the fusarium in liquid culture was observed and amounts of biotin up to 0.1 microgram per culture further increased the dry weight. Some isolations made from old cultures of the fungus grew in the absence of biotin; these were interpreted to be saltations or dissociations.

New evidence concerning the configurations of the alpha and beta glucosides: C. S. HUDSON, EDNA M. MONTGOMERY, and NELSON K. RICHTMYER. Charles Tanret discovered in 1894 that the naturally occurring glucoside *picein* is converted to levoglucosan by the action of hot barium hydroxide solution. *Picein* is *p*-hydroxy-acetophenone-β-D-glucopyranoside. We find that β-phenyl-D-glucopyranoside is converted to levoglucosan similarly. On the other hand, α-phenyl-D-glucopyranoside is not affected by the alkaline treatment. These new facts prove the configurations of the alpha and beta glucosides, levoglucosan and similar anhydrides.

The electrophoretic study of complexes between proteins and related compounds: D. A. MACINNES and LEWIS G. LONGSWORTH. In our study of egg white, by a modification of the method of Tiselius, evidence was obtained that complexes exist between the proteins in the naturally occurring material and also in salt and buffer solutions. The evidence comes largely from the fact that in certain cases the electrophoretic patterns for the rising and descending boundaries are not, even approximately, mirror images of each other, as would be expected if the components were electrophoretically independent. The effect is greatest for relatively high protein concentrations, and low salt contents, of the solutions used in the studies. Complexes are most often found between proteins on opposite sides of their isoelectric points, but this is by no means a necessary condition for their occurrence. As type systems, electrophoretic studies have been carried out systematically with mixtures of ovalbumin and yeast nucleic acid, and on this nucleic acid with ovomucoid, varying the relative concentrations, the pH values and the ionic strengths. The electrophoretic pattern for a mixture of ovomucoid and nucleic acid is particularly interesting in that it indicates a peak for an extra component. The apparent relative concentrations, as indicated by the areas under the different peaks of the patterns, are altered by complex formation. With the mixture of ovalbumin and nucleic acid the components were found to form complexes if the pH were near or below the isoelectric point of ovalbumin, but to be electrophoretically quite independent at high pH values.

The role played by radiation mutations in mankind: H. J. MULLER. Calculations are presented of the average number of generations to be expected between the production of a recessive gene-mutation in man and its manifestation in a homozygous individual. The chance of the mutated gene meeting another like it that originated by an independent mutation depends on the frequency of such mutations, on the survival value of the abnormal type and on the randomness of breeding. Taking the maximal values for these factors (the values favoring the highest frequencies of recessive abnormalities), it turns out that at least 30 or, more likely, over 100 generations would on the average occur—i.e., 750 to 3,000 years or more—before a seriously harmful recessive abnormality (one having less than 90 per cent. of normal survival) would manifest itself by this process. Another mechanism of manifestation involves the meeting of two genes, each descended from the same original mutated gene. The frequency of this depends upon the total degree of inbreeding. A new method for gauging this is presented, involving the principle that the frequency of homozygosis from this cause is one fourth the frequency of marriages between two related individuals having the same name. From statistics on this point and on cousin marriages it is found that, even in the most closely inbred groups in modern civilized society, the chance of a mutated gene manifesting itself by this process is not over 0.5 per cent. This represents a "latent period" of some 5,000 years. Both processes together would give over 600 and probably thousands of years of latency. The large number of mutated genes accidentally dying out while thus "under cover" are compensated for by those accidentally multiplying. Thus the inherited damage from irradiation, though so long postponed, is in no wise prevented. Judging by results in mice (P. Hertwig), we may provisionally take the order of frequency of seriously harmful recessive mutations induced by 300 *r* as one to several per cent. (perhaps doubling the natural frequency). This chance of damage would seldom overweigh the direct benefits of diagnostic or therapeutic irradiations, excepting those designed to stimulate or temporarily inhibit reproduction. However, in irradiation intended for other parts, the gonads should be shielded. Natural radioactivity, while of no consequence in flies, may appreciably influence human mutation frequency. For the long duration of the human generation sometimes allows the reception of ten or more *r*. Thus, under special conditions, the amount might conceivably be enough to be significant in evolution.

The control of ovum growth: GREGORY PINCUS (introduced by H. J. Muller). Rabbit ova were cultured *in vitro* under conditions which allow definite but limited blastocyst growth. An analysis of the processes controlling ovum growth was undertaken by adding to the cultures (1) various substances which are specific poisons for known components of carbohydrate-splitting enzyme systems and (2) various presumable substrates and growth-promoting substances. Ovum growth was found to be inhibited by low concentrations (10^{-4} to 10^{-5} M) of the following poisons: cyanide, iodoacetate, fluoride, selenite. Partial growth inhibition was exerted by high concentrations of glyceraldehyde and malonate. The following putative substrates were ineffective as growth stimulants:

glucose, glucosephosphate, oxalacetate, malate, succinate, fumarate, lactate. Neither riboflavin nor coenzyme I was growth-stimulating. Pyruvate in moderate concentration (0.003 M) proved an effective growth stimulant. The growth-inhibiting effect of fluoride was overcome by pyruvate. Vitamin B1 proved an excellent growth stimulant, as did the sulfhydryl compounds glutathione, cysteine and thioglycolic acid. Insulin was moderately growth-stimulating. Ova fail to grow under completely anaerobic conditions. These findings are taken to indicate that the energy for growth is derived (1) at least in part by an oxidative process, (2) by the glycolytic degradation of carbohydrate, and (3) chiefly by the action of a phosphorylating enzyme system. The limiting process appears to involve the metabolism of pyruvic acid since (1) the poison (fluoride) inhibiting the production of pyruvic acid may be counteracted by addition of pyruvate in excess, (2) vitamin B1 probably functions as part of a pyruvate splitting system, (3) the sulfhydryl compounds may act as cocarboxylases to a system affecting the decarboxylation of pyruvate. Insulin may act as a donor of sulfhydryl-containing substance. Pyruvate appears normally to be derived from triose phosphate and not from oxalacetic acid since the latter was not growth-stimulating, whereas the former was. The relation of these findings to hormone-controlled growth *in vivo* and the utility of these methods for determining the nature and necessities of embryo nutrition will be indicated.

Morphological changes in amputated nerveless limbs of urodele larvae: OSCAR E. SCHOTTÉ and ELMER G. BUTLER (introduced by E. Newton Harvey). By repeated resections of the brachial plexus, forelimbs of Urodele larvae have been maintained in a nerveless condition for several weeks and in some cases for as long as two months. A limb, completely devoid of spinal innervation, not only loses its capacity for regeneration, but also, after amputation, it undergoes radical morphological changes. Beginning at the level of amputation and proceeding proximally, structures of an amputated nerveless limb undergo regression and resorption. This structural regression brings about extreme reduction in size and eventually complete disappearance of the limb. Histological studies demonstrate that the regression is the result primarily of cellular dedifferentiation. All formed structures of the limb, including skeleton and muscles, go into extreme dedifferentiation and gradually disappear. Moreover, dedifferentiation in a nerveless limb involves not only those structures injured at the time of amputation, but also those remote from the amputation level. Articulations do not serve as barriers to the dedifferentiative processes. Amputation through the metacarpals, for example, results in dedifferentiation and disappearance of metacarpals, carpals, radius, ulna and most of the humerus, together with all other tissues in these regions. In such a case, fourteen skeletal elements are involved in the dedifferentiation, thirteen disappearing completely, although only four of these structures were injured at the time of amputation. These radical morphological changes are not the result primarily of physiological atrophy, but represent alterations in the specific character of limb tissues, caused by the disturbed unrolling of regenerative processes. Since control experiments show that denervation alone only impedes further growth processes, but is not followed by regression of structures, the above results reveal the importance of amputation for the normal course of regeneration. Unamputated nerveless limbs exhibit no dedifferentiation; amputated nerveless limbs show extreme dedifferentiation and reduction, leading to eventual disappearance of the limb. The nervous system, therefore, formerly regarded as exerting primarily a trophic influence on cellular activities during regeneration, must now be considered as an important agent of the organism as a whole, enabling amputated limbs to carry on the complex cellular interactions for regeneration.

Developmental variations resulting from the androgenetic hybridization of four forms of Rana pipiens: K. R. PORTER (introduced by James B. Murphy). Removal of the second maturative spindle of the frog's egg following entrance of the sperm nucleus, deprives the egg of its pro-nucleus and permits the association of nuclei and cytoplasms from different species or different races of the same species in the formation of heterospermic haploid embryos. This procedure has recently been employed to combine reciprocally the nuclei and cytoplasms of what appear to be four different geographic races of *Rana pipiens.* A comparative study of the early embryology of the one homospermic and the three heterospermic haploids resulting from the combination of any one type of cytoplasm with all four types of nuclei shows: (1) that the morphogenesis of the heterospermic haploids differs from that of the homospermic control; (2) that the variations shown appear to be of the same *order* but of a different *degree;* (3) that if the nucleus is derived from a more northerly source than the cytoplasm the departure from the normal is in one direction, if from a more southerly source, in the opposing direction; (4) that in general the further removed the nuclear source from the cytoplasmic the greater the degree of variation. Comparative examination of diploid control and hybrid embryos resulting from combinations of the same gametes reveals the same features though not so pronouncedly. When the data derived from using various cytoplasmic types in combination with the four nuclear types are brought together and compared, it is possible to observe the results of combining different cytoplasms with the same nucleus. From the standpoint of comparative morphogenesis these results show the features listed above. It is concluded that the cytoplasms used differ in factors which influence early development and, in terms of morphogenetic expression, it appears that the variations in these factors are related in some way to the geographic distribution of the parent races. The same can be concluded concerning the four types of nuclei used.

Studies on pain: measurement of the threshold for an alarm reaction in man and its relation to pain perception: J. D. HARDY, H. GOODELL and H. G. WOLFF (introduced by Eugene F. DuBois). The thermal stimulus necessary to evoke a barely perceptible change in skin resistance was measured. This change in skin resistance is a type of

alarm reaction. The method was essentially the same as that described for the measurement of the pain threshold. Heat from a 1,000-watt lamp was focused by a condensing lens onto the blackened skin of the forehead for exactly three seconds. The intensity of the radiation evoking a reaction was measured by means of a radiometer. It has previously been demonstrated that the intensity of stimulus required to produce pain was the same regardless of the size of the skin area stimulated, and was approximately uniform in all individuals. In contrast to this uniformity in the threshold for pain are the wide variations which occur in the threshold of the alarm reaction. It was observed that the intensity of radiation necessary to evoke a reaction was less with large areas of exposed skin than with small. With the large areas, ca 30 cm² the threshold of reaction was as small as 0.08 that of the pain threshold and varied appreciably from time to time in the same person, and from person to person. For areas of skin smaller than 3 cm² the threshold of reaction was not so variable and usually approximated the pain threshold. It was inferred that the greater degree of discomfort experienced with the larger areas of exposed skin was due to the spatial summation of sensations of heat and warmth; that the reaction threshold was less variable with the smaller areas, due to the fact that a reaction usually followed when the pain threshold had been reached, and the latter was independent of the size of the area exposed. It was concluded, also, that the reaction after stimulation of the small area is due to pain, and with the large areas to the state of alertness or alarm resulting from the strong sensation of heat or warmth. The threshold level of the alarm reaction appeared to be related to the emotional state of the subject at the time. The administration of an analgesic agent such as acetylsalicylic acid when large areas were exposed raised the alarm reaction threshold to the pain threshold, and in the case of alcohol, higher than the pain threshold.

Hormones capable of increasing liver fat: OSCAR RIDDLE and DAVID F. OPDYKE. Hormones derived from the ovary, pancreas, adrenal and especially from pituitary glands have been studied with reference to their ability to increase the storage of fat in the livers of young pigeons and rats. Since unlike results were obtained with these two species this report is restricted to effects produced in pigeon livers following daily treatment during two to four days. Neither leuteinizing hormone, adrenotrophin, intermedin nor the inseparable mixture of gonadotrophin and thyrotrophin increases liver fat when those hormones are used in the purest form now available. Prolactin usually, but inconsistently, increases the liver fat in pigeons (not in rats) though it regularly increases the size of hepatic cells in pigeons. Insulin, desoxycorticosterone acetate and estrone all increase liver fat. Anterior pituitary fractions obtained by ammonium sulfate precipitation, with dialysis of precipitates formed at one-third (and one-half) saturation, have resulted in appreciable concentration of liver fat activity in the water-soluble portion of the precipitate formed at one-third saturation. This fraction contains notable quantities of adrenotrophin, thyrotrophin, gonadotrophin and (traces of) posterior-lobe hormone, but it is almost free from prolactin. The "pseudoglobulin" fraction (*i.e.*, the water-soluble part of the precipitate formed at one-half saturation) obtained in this series (done according to Young, 1939), though contaminated in fairly equal degree with all the hormones listed above for the highly potent fraction (and likewise almost free from prolactin), is practically free of liver fat activity. Pituitary extracts apparently show liver fat activity in all or many species, but it is not probable that this activity is produced by a single substance and not yet proved that an extract which is effective in one species is widely effective in others. This investigation was supported by a grant from the Committee on Research in Endocrinology, National Research Council.

Field properties of the developing frog's egg: H. S. BURR (introduced by L. L. Woodruff). The present report is a study of some six thousand determinations on fifty frogs' eggs prior to the development of the long axis of the embryo as seen in the appearance of the medullary plate. Potential differences between the vertex of the animal pole and four equidistant points on the equator of the egg were measured by the Burr-Lane-Nims technique. Three variations in the technique were employed and all were subjected to statistical analysis. From the very beginning it was apparent that at least one of the four points showed a significantly greater voltage drop from the vertex than any of the other three. This point was then marked either by staining by Nile Blue sulfate or by the establishment of orientation points in the immediate environment of the egg. Of the fifty embryos, ten were marked successfully and developed to the neural plate stage. In the remaining forty, correlations were either not attempted or were impossible because of technical difficulties. It should be noted that the technique is rigorous and requires great care in its manipulation, and technical artefacts therefore frequently creep into the study. In every case where correlations were possible, the primary axis of the organism came to lie along the plane which showed the greatest voltage drop from the vertex. In other words, it was possible to predict from the voltage pattern where the head end of the organism would develop. It is hard to escape the conclusion, therefore, that the electrical pattern is primary and, in some measure at least, determines the morphological pattern. Added weight is given to the argument by the following facts. Typical field patterns have been observed in the unfertilized egg where they last for three or four days after laying. When obvious signs of cell death appear, the voltage gradients disappear. In like manner, the same pattern is to be seen in the fertilized but undivided egg. Moreover, it can be followed through the early stages of segmentation, the formation of the morula, the gastrula, and even shows the same characteristics in the early medullary plate stage. It seems clear from the above that, at least in the frog's egg (and in the egg of Amblystoma, for some preliminary studies in the latter confirm these findings) there exists an electrical field which appears prior to the appearance of the formed structures and also predicts the longitudinal axis of the future embryo.

The methods of excitation of melanophores in the skin of the catfish Ameiurus: G. H. PARKER. To test the possibility of direct action of neurohumors on the melanophores of such a fish as the catfish, it is necessary first of all to to denervate the melanophores. The older technique of nerve cutting and scale removal supposed to accomplish this step really failed, for it left remnants of living nerve attached to the melanophores. To remove this last nervous remnant fishes must be kept alive after the operation some two weeks, thereby insuring nerve degeneration. When catfishes thus treated are tested by injection of intermedine, acetylcholine or adrenaline, the three normal chromatic neurohumors of this fish, their denervated melanophores respond as their innervated ones do. It is therefore concluded that these three neurohumors act directly on catfish melanophores, intermedine and acetylcholine expanding these cells and adrenaline contracting them. Intermedine originates in the pituitary gland of the catfish and is carried in its blood and lymph to its melanophores. Acetylcholine and adrenaline are products of its two sets of chromatic nerve fibers and are discharged in close proximity to the melanophores. These neurohumors appear first to enter and be stored in the lipoids of the tissue close to the color cells and to escape later from these protective reservoirs in solution in the lymph and thus to reach the color cells. In this way acetylcholine and adrenaline may be stored, protected and subsequently used, as they pass from the nerves to the melanophores in contrast with intermedine, which appears not to be subject to this kind of storage.

Anthropological connections between America and Siberia: ALEŠ HRDLIČKA. Since 1926, under the auspices of the Smithsonian Institution, systematic anthropological researches and excavations were carried on in Alaska. They resulted in the accumulation of extensive and comprehensive skeletal materials from the territory, now deposited in the U. S. National Museum. The study of these collections, thanks to the Soviet authorities and men of science, it was possible in 1939 to supplement with that of approximately 600 crania of various Siberian populations, from the Neolithic times onward. As partly reported to the academy at its last annual meeting, the Neolithic skulls from the Angara and upper Lena region showed remarkable similarities with the oblong type of skull of the American Indian. It is now possible to supplement this with the evidence shown by the more recent Siberian, and the Alaskan as well as other American materials. The total is based on approximately 4,000 normal adult crania, the essential metric data on which are now ready for publication. These data show definitely a close affinity between the aboriginal Siberians and Americans. In some instances the relation between a Siberian and an American group is so close as practically to amount to identity. And similarly some of the Old Alaskan resemble certain mainland American groups. The now available evidence makes it possible, in brief, and besides the Neolithics who have already been discussed, to identify the Eskimo with the Chukchi, and the Aleuts with the broader-headed type of the Tungus; nor do the resemblances stop there. In addition, the crania of the newly discovered Pre-Aleuts are seen to show a very near resemblance to the Siouan type; those of the similarly newly found Pre-Koniags of the Kodiak Island to the Algonkin type; and those of the Koniags, the people found on Kodiak at the advent of the Russians, with the southern Indian Alaskans. Thus, from the physical point of view, which alone can be reliable in the classification of human groups, America may now be definitely connected with Siberia, and Alaska with the rest of America.

The causes of migration within the United States: E. L. THORNDIKE. Measures of the attractive power of one state over another were computed for each of the 1,128 pairs of states. Measures were obtained of the differences between each pair of states in longitude west, latitude north, predominance of agriculture relative to manufacturing, per capita income (more exactly an index paralleling it), the general goodness of life for good people, and other variables, eighteen in all. An analysis of the relations between the ratio

$$\frac{\text{Born in state A but residing in state B}}{\text{Born in state B but residing in state A}},$$

and the difference measures (longitude of state B minus longitude of state A, latitude of state B minus latitude of state A, income index of state B minus income index of state A, etc.) by the methods of multiple correlation showed such facts as the following:

Let M = the measure of interstate migration $\frac{\text{Born in state A residing in state B}}{\text{Born in state B residing in state A}}$.
Let L = the longitude (west) of state B minus the longitude (west) of state A.
Let I = the income index of state B minus the income index of state A.
Let G = the general goodness index of state B minus the general goodness index of state A.

Then, for native-born Negroes alive in 1930, the variation in M is "determined" or, in the common-sense meaning of the word, caused:

52 hundredths by what is measured by I and not by L or G
8 hundredths by what is measured by L and not by I or G
3½ hundredths by what is measured by G and not by I or L
25 hundredths by what is common to I and G
3 hundredths by what is common to I and L
2 hundredths by what is common to G and L
6½ hundredths by factors not measured by L, I or G

The fauna of the Uinta Eocene: W. B. SCOTT. The Uinta formation, so-called from the Uinta Mountains, along the southern flank of which it lies, is unquestionably referable to the Upper Eocene. It is plainly divisible into three parts, which in ascending order are called, respectively, A, B and C. Relatively speaking, the fauna is not very rich, obviously due to the conditions of preservation. The number of genera of mammals so far named in the fauna is 55 as compared with 102 of the White River, which succeeds the Uinta after an interval. Fishes are known only from fragments; lizards and snakes have not been found, but large crocodiles continue from the Bridger formation, which directly underlies the Uinta, indicative of a warm climate. The mammals are in a most interesting way transitional between those of the older Bridger and the succeeding White River. A number of genera

hold over from the Middle Eocene or are but slightly modified successors of the Middle Eocene genera. The primitive Carnivora referable to the sub-order Creodonta continue in considerable numbers. The true carnivores, Fissipedia, are few in number and restricted to the group of primitive dogs. No other family of Fissipedia has been found. Most of the fossils, as is generally the case, are those of hoofed animals and these are likewise of a transitional sort. We find here the last of the extraordinary six-horned Dinocerata, which are so characteristic of the Bridger, occurring in the Lower and perhaps the Middle divisions of the Uinta and then disappearing. Perissodactyla are still of the Bridger type and are very numerous and diversified. Most of them belong to the family of the brontotheres, and some of these have developed horns of a very conspicuous type. The most striking change, as compared with the Bridger, is in the great number of Artiodactyls. Aside from certain pig-like forms the great bulk of these Artiodactyls were ruminants and allied to the camels. Almost all the White River families of Artiodactyls are represented in the Uinta, but all these families are much closer together than the White River descendants are, indicating their convergence backwards to a common ancestry. The smaller mammals are extremely scarce in the Uinta beds so that the number of rodents is much less than we believe to have lived at that time. I have undertaken to prepare for the American Philosophical Society a Monograph of the Uinta Mammals, which will be prefaced by a stratigraphical study by Dr. John Clark, of the Carnegie Museum of Pittsburgh.

The correlation of the Cambrian formations of northeastern North America with those of other parts of the continent: B. F. HOWELL (introduced by Arthur Keith). Until recently stratigraphers have been unable to correlate satisfactorily the Middle and Upper Cambrian formations of Newfoundland, eastern Canada and New England with those of other parts of North America. The discovery of additional faunas in Newfoundland, Quebec, Vermont, the southern Appalachians, the western United States and the Canadian Rockies, and a consequent better understanding of the age relationships of the Cambrian faunas of the entire continent, now make the correlation of the northeastern formations with those of the south and west feasible. The succession of Cambrian strata in the northeast, previously believed to represent most of Cambrian time, is now found to present a very incomplete sedimentary and faunal record. A more complete record can be pieced together from other quarters of North America, and this enables us to interpret the fragmentary northeastern succession. Many genera of fossils are now known to have had a geographic range which embraced both the northeastern area and other parts of the continent. Since the faunas of the northeastern region are very similar to those of northwestern Europe, while the faunas of western North America resemble those of eastern Asia, stratigraphers can now make better correlations than heretofore of Cambrian formations throughout both hemispheres.

Further light on the origin of the Carolina "Bays": DOUGLAS JOHNSON. In earlier papers evidence has been presented to show that the supposed meteorite scars of the Carolina coast are the product of artesian spring action accompanied by solution which produced basins occupied by lakes, the waves of which built beach ridges about the shores, while dominant winds transported sand to form larger dune ridges having major development around the southeastern quadrants of the depressions. Airplane photographs recently available demonstrate that in certain areas the basins are pear-shaped rather than oval, and have their major axes oriented more nearly north-south than do the oval basins first discovered. The new evidence available seems to negative the meteoritic intrepretation of "bays" origin, and to support the hypothesis of terrestrial origin outlined above.

The batholith of southern California: ESPER S. LARSEN (introduced by Arthur Keith). The great batholith of Southern California underlies a strip from 60 to 100 miles wide and 1,000 miles long from near Riverside, California, to the southern tip of Lower California. It is larger than the batholith of the Sierra Nevada, to which it is probably closely related. The elongation of the batholith is essentially parallel to the structure of both the older and younger rocks. Its age is Late Jurassic or Cretaceous. A strip across the batholith and 70 miles along its length was studied by the author as a sample of the batholith. This strip is made up of many separate injections and for the most part early injections had become largely crystalline before succeeding magmas were intruded. The succession of intrusions was from gabbro to granite. The average rock is a tonalite. The gabbro and granodiorite are confined to the western part of the batholith. Thirty-four chemical analyses of carefully selected rocks of the batholith are plotted on a variation diagram. All but a few fall near a smooth variation curve. This curve is somewhat different from that for the Sierra Nevada batholith. Dark inclusions are present in all the rocks and they are abundant in some. They tend to be disc-like and subparallel. The form of the individual intrusive bodies and their relations to the wall rocks indicate that the magmas were emplaced by stopping and not by forcible injection. The first intrusion, a gabbro, represents the primary magma, and the other magmas were formed by a combination of crystal differentiation and assimilation. Most of the larger mapped units of the batholith are present in several bodies that are widely separated. Only a few of these bodies underlie areas as large as 200 square miles. The relative uniformity of the various bodies of any particular intrusion can not be due to the fact that all the bodies come from a single well-mixed, uniform, deep-seated magma. It seems much more likely that widespread diastrophic forces formed the long body of magma and that later diastrophism determined the stages in differentiation at which bodies of magma were moved toward the surface. Some intrusions were preceded by shattering and mixing of fragments of the wall rock in a large body of magma. In one widespread tonalite the inclusions must have been incorporated in the magma shortly before its final emplacement, as they were almost completely reacted on, softened, and drawn out but not disintegrated. In another the inclusions were disintegrated but not com-

pletely assimilated, indicating more mixing but less assimilation. Local diastrophism emplaced the several small bodies of granite and the numerous small, local bodies of other granitic rocks.

Basement influence on Rocky Mountain structures: ROLLIN T. CHAMBERLIN. The more the Rocky Mountains are studied, the more it becomes evident that pre-existing structures and strength variations in the underlying basement rocks have had great influence in determining the pattern of the present ranges and the nature of yielding under the Laramide compression which produced them. Where the complex crystalline rocks were deeply buried beneath a thick cover of weaker geosynclinal sedimentary strata, the latter were folded with relative regularity in long, linear, nearly parallel ranges which extend through many degrees of latitude. But in the foreland area to the east, where only 10,000–15,000 feet of Paleozoic and Mesozoic strata overlay the basement complex, the structures and rock differences of the latter were sufficiently close to the surface to exert a strong control which upset the regularity of the Rocky Mountain deformation. The result was an uplifting of variously oriented block-like or oblong ranges and a sinking of basins of quite irregular pattern. The basement control was manifested chiefly in two ways. (1) Pre-existing zones of faulting in two cross sets (roughly north-south and east-west) have outlined rectangular areas which deformed each with a certain individuality of its own. In south-central Montana block-like areas were moderately uplifted without much tilting. Differential horizontal movement also occurred, particularly on the east-west lines, the south block in each case shifting east relative to that on the north. To the south, much stronger uplifts developed the Beartooth, Pryor, Bighorn and other mountain groups far east of the Rocky Mountain front in northern Montana and Canada. The crustal adjustment involved in this easterly offsetting was accomplished in part by the differential horizontal shifting. These mountain groups are composed of transverse subunits, some tipped up most on the northeast, others on the southwest, developing a remarkable reversal of asymmetry in alternating segments of the ranges. (2) The Laramide folding of the Beartooth, Bighorn and Black Hills has also accentuated old pre-Cambrian dome-like uplifts with batholithic cores. These outlines, however, are at variance with the block fracturing; but in places the two have combined in a composite basement control. The individuality of the foreland ranges, their divergencies from the general northwest-southeast Rocky Mountain alignment and their particular behavior have resulted from this composite control. The numerous minor folds, involving chiefly the sedimentary cover, have been much less influenced by the basement and follow closely the regional northwest-southeast Rocky Mountain trend.

Biographical memoir of David Watson Taylor: WILLIAM HOVGAARD.

OBITUARY

ANNIE JUMP CANNON

ON the thirteenth of April, 1941, the world lost a great scientist and a great woman, astronomy lost a distinguished contributor and countless human beings lost a beloved friend by the death of Miss Annie J. Cannon.

Miss Cannon was born in Dover, Delaware, in the year 1863. In days when an education for women is easily come by, it is hard to appreciate the enlightenment of a parent who was willing to further a daughter's "higher education" in the seventies and eighties of last century. Her father gave effect to her early delight in the phenomena of nature, and she entered the class of 1885 at Wellesley. Not long ago she was recalling those early days; one might have expected the girls to be very serious and earnest, she said; but they always seemed to be laughing. And in that spirit she went through life, always endowing what seemed to many people an impossibly laborious and exacting occupation with joy and vitality.

After completing her studies at Wellesley, Miss Cannon came in 1896 to the Harvard Observatory, then under the directorship of Edward C. Pickering; and here for the first time she began those studies of stellar spectra with which her name will always be associated, although they were by no means the sum total of her contribution to science. The study of the spectra of the southern stars, published in 1901 in Volume 28 of the Annals of the Harvard College Observatory, was her first major research. This work is still a treasure-house of information for the student of stellar spectra, but its greatest interest probably lies in the fact that the system of spectral classification that later came into general currency was here crystallized for the first time.

The Henry Draper Catalogue (named in honor of the first man to photograph stellar spectra) was the outcome of the earlier studies of stellar spectra; and when the means were available for the execution of the immense task of classifying the spectra of almost a quarter of a million stars, it was Miss Cannon whom Pickering selected for carrying it out. Of the value of the Henry Draper Catalogue to science it is almost unnecessary to speak; there is not a branch of astronomy or astrophysics that has not drawn upon it, and will not cease to draw upon it for many years to come. But perhaps it is not unbefitting to speak of the labor that was involved in producing so great a work. The classification of the spectra themselves—most of them from more than one photograph—though a great undertaking, was by no means the major part of the work; it was carried out during the space of only

five years. Even greater was the labor of identifying and arranging the entries, and of preparing and issuing the nine volumes of the Harvard Annals that contain the catalogue. Pickering, who found in the Henry Draper Catalogue the culmination of his work as director of the Harvard Observatory, lived to see the publication only of the first three volumes; the completion of the remaining six fell largely upon Miss Cannon. The nine volumes were issued between 1918 and 1924. They are Miss Cannon's greatest legacy to science.

When the ninth volume of the catalogue was issued, Miss Cannon was sixty years old, and many men and women might have felt justified in thinking that their life-work had been completed. But with the astonishing vitality that marked all her actions, she at once embarked on the even more laborious and exacting task of classifying the spectra of yet fainter stars. This work led to the completion of a number of successive sections of the "Henry Draper Extension," less known, perhaps, than the great catalogue, but not less significant, for they contained intensive studies of stellar regions of particular interest. The program that she had undertaken was of heroic proportions, and she worked upon it, without intermission, until a few weeks before her death. In addition to the studies of stellar spectra published at Harvard, Miss Cannon was never too busy to carry out the classification of stars for other investigators, whether it involved looking up a puzzling star for a colleague, or the classification of all accessible stars in the Yale Zone Catalogue or the Cape Zone Catalogue, for publication in those volumes.

Had Miss Cannon never worked in stellar spectroscopy, she would still have put the astronomical world greatly in her debt by her early studies of variable stars. Her first years at the Observatory coincided with the first outburst of the photographic study of stellar variability—a study that has gone far to transform astronomy. The astronomical literature of the first two decades of the present century bears witness to her important contributions to the study of variable stars. She never lost touch with the subject; and her complete catalogue of all papers relating to variable stars, always kept up to date, has been of immeasurable value to her colleagues.

A bibliography of Miss Cannon's scientific work would be exceedingly long, but it would be far easier to compile one than to presume to say how great has been the influence of her researches in astronomy. For there is scarcely a living astronomer who can remember the time when Miss Cannon was not an authoritative figure. It is nearly impossible for us to imagine the astronomical world without her. Of late years she has been not only a vital, living person; she has been an institution. Already in our schooldays she was a legend. The scientific world has lost something besides a great scientist.

During the past twenty years, Miss Cannon was the subject of many academic honors, which she received with genuine and infectious pleasure. Honorary degrees were conferred on her by the University of Delaware, the University of Groningen (Holland), Wellesley College, Oxford University (England), Oglethorpe University and Mount Holyoke College. In 1931 she was awarded the coveted Draper Medal of the National Academy of Sciences, and in 1932, the Ellen Richards research prize.

A life of such distinction could not but be reflected in the furtherance of the education of women. Miss Cannon herself took pleasure in this result, and several younger generations of women scientists have owed much to her kindness, help and encouragement.

As it would be an impertinence to presume to say how great a loss the scientific world has sustained, it would be an impossibility to measure the personal loss that has befallen Miss Cannon's human friends. To them she was not the great scientist; she did not bore them by talking about stellar spectra. She was a human being, and as such they loved her—they, and their children and their grandchildren. Perhaps the greatest tribute that I can pay to her memory is to say that she was the happiest person I have ever known.

CECILIA PAYNE GAPOSCHKIN

RECENT DEATHS AND MEMORIALS

DR. JOSEPH ELLIS TREVOR, since 1934 professor emeritus of thermodynamics at Cornell University, died on May 4. He was seventy-six years old.

DR. MORTON GITHENS LLOYD, since 1917 principal engineer and chief of the Safety Codes Section of the National Bureau of Standards, died on April 26 at the age of sixty-seven years.

ELIZABETH FLORETTE FISHER, professor of geology and geography at Wellesley College, who until her retirement with the title emeritus in 1926 had been connected with the college for thirty-two years, died on April 25 at the age of sixty-eight years.

DR. FAREL LOUIS JOUARD, otolaryngologist of the New York Ophthalmic Hospital, died on April 27 at the age of fifty-seven years.

DR. HAROLD LYNWOOD WARWICK, practising aurist of Fort Worth, Texas, died on April 28 at the age of sixty-three years.

DR. ARTHUR LAPWORTH, since 1935 emeritus professor of chemistry at the University of Manchester, died on April 5.

DR. JOHN SMYTH MACDONALD, emeritus professor

of physiology at the University of Liverpool since 1932, died on March 29 at the age of seventy-three years.

Dr. Walther Vogt, professor of anatomy in the University of Munich, died on March 17. He was noted for his important work on the embryology of the Amphibia, particularly for the use of vital-strain markers in tracing the movements of cells during development.

A portrait of the late Professor Edward B. Titchener, formerly professor of psychology at Cornell University, has been hung in the Laboratory of Psychology, which he founded. The portrait was painted by Professor Christian Midjo and was presented to the university by Mrs. Titchener.

The American Pharmaceutical Association accepted on May 3 a bronze statue of William Procter, Jr., one of the earliest teachers of pharmacy in the United States, from James E. Hancock, chairman of the committee. The date of the unveiling is the hundred and thirty-fourth anniversary of Procter's birth. The exercises were held in the foyer of the American Institute of Pharmacy, Washington, D. C. Dr. Ivor Griffith, president of the Philadelphia College of Pharmacy and Science, where Procter taught, delivered the principal address. Charles H. Evans, president of the American Pharmaceutical Association, accepted the statue.

SCIENTIFIC EVENTS

AIR-RAID DAMAGE TO THE LABORATORY AT PLYMOUTH OF THE MARINE BIOLOGICAL ASSOCIATION[1]

During the recent air-raids on Plymouth, the Laboratory of the Marine Biological Association suffered severely. The buildings, though still standing, have sustained heavy damage. All windows except a few on the south side of the top floor of the main building have gone; ceilings are down, doors wrenched off, and much structural damage caused by the blast. The director's house was completely burnt out. The library, very fortunately, is intact except for the loss of windows and the skylight, and it has now been made waterproof. At the eastern end of the north building damage is most severe, but the greater part of the equipment and apparatus is intact. The Easter-class house will no doubt have to be rebuilt, but most of the roof remains. Other outbuildings, including the dog-fish house, director's garage and stores, and the constant temperature rooms, have all sustained damage. The exact extent of the structural damage to the buildings can not be determined without expert assistance, but it is hoped that the laboratories themselves can be restored. The tanks on the north side of the Aquarium burst and the supply pipes broke, but it is hoped that some part of the circulation may be restored before very long.

It will evidently be a long time before permanent repairs can be undertaken. Since materials for urgent work are extremely short, the cellotex sheeting on the first and second floors of the main laboratory is being taken down and used to replace windows. It is hoped to fit a small glass pane in each room, and if the cellotex is well painted, it is expected to remain weatherproof for a year or two. In a few weeks it may be possible to accommodate research workers who require only limited facilities, but this must depend largely upon the restoration of electricity and water supplies. There is no difficulty concerning general administration, as most documents have been salved. For the time being it will not be possible to supply orders for specimens, but it is hoped that in the course of a few weeks some of the normal facilities will be available.

[1] From *Nature*.

THE INSTITUTE OF PHARMACY OF THE UNIVERSITY OF WISCONSIN

An American Institute of the History of Pharmacy has been established at the University of Wisconsin. It is planned that it shall be a center for all pharmaceutico-historical information and work by both North and South America. It will be directed by Dr. George Urdang, who came to the United States in 1938 and who has been connected with the university since July, 1939. Dr. Urdang was formerly director of the German Society of the History of Pharmacy, and was the founder of the International Society of the History of Pharmacy. Among the founders of the institute are Dr. Edward Kremers, director emeritus of the School of Pharmacy of the university; Dr. Louis W. Busse and Dr. Lloyd McC. Parks, both members of the faculty; Jennings Murphy, Milwaukee, secretary of the Wisconsin Pharmaceutical Association, and Dr. Arthur H. Uhl, director of the department.

In addition to the director of the institute, Dr. Urdang, Dr. Uhl is president and Mr. Murphy is secretary-treasurer. The vice-presidents are Dr. B. V. Christensen, dean of the School of Pharmacy at the Ohio State University; Dr. Rufus A. Lyman, of the department of pharmacy at the University of Nebraska, and Dr. J. Leon Lascoff, pharmacist of New York.

Members of the council include Oscar Rennebohm, Madison, president of the State Board of Pharmacy; Dr. Edward J. Ireland, professor of pharmacy at Loyola University; Conrado F. Asenjo, research

chemist of the School of Tropical Medicine, Puerto Rico, and Dr. Charles O. Lee, professor of pharmacy at Purdue University.

The objectives of the new institute, as given in an official statement issued by Dr. Uhl, are:

To aid in the collection, selection, arrangement and exhibition of pharmaceutico-historical material and to catalogue and inventory this material;

To give the research worker in the field of historical pharmacy the possibility to discuss his projects, to get advice on literature and to publish the manuscripts concerned;

To furnish information and means for historical instructions at the colleges of pharmacy;

To furnish material for popular pharmaceutico-historical information directly to the general public or to individual pharmacists for use in their social and professional relations;

To cooperate with the historians of the related sciences and professions, especially of medicine, in order to promote the mutual scientific, professional and social progress and understanding derived from such cooperation.

NATIONAL SCIENCE FUND OF THE NATIONAL ACADEMY OF SCIENCES

ORGANIZATION of the National Science Fund, a new foundation to receive and administer gifts for the advancement of science, was announced on April 29 by Dr. Frank B. Jewett, president of the National Academy of Sciences, during the second day's program of the annual meeting of the academy. The National Science Fund will be directed by a joint board made up of scientists selected from the academy membership and distinguished laymen, and is designed to permit donors who wish to promote human welfare through support of scientific research to take advantage of the facilities of the academy and of its agency, the National Research Council. The twelve lay members of the first board of directors are:

Winthrop W. Aldrich, New York City
James F. Bell, Minneapolis
John W. Davis, New York City
Homer L. Ferguson, Newport News, Virginia
Walter S. Gifford, New York City
Carlton J. H. Hayes, New York City
Archibald MacLeish, Washington, D. C.
Harvey S. Mudd, Los Angeles
Elihu Root, Jr., New York City
Tom K. Smith, St. Louis
Lewis L. Strauss, New York City
Harold H. Swift, Chicago

The academy appointed twenty scientific men from its own membership to serve as directors, and designated Dr. William J. Robbins, director of the New York Botanical Garden, as acting chairman of the board. The scientific directors appointed by the academy are:

Dr. Roger Adams, professor of chemistry, University of Illinois.

Dr. James R. Angell, formerly president of Yale University, now educational director of the National Broadcasting Company.

Dr. A. F. Blakeslee, director of the department of genetics of the Carnegie Institution of Washington, Cold Spring Harbor, Long Island, N. Y.

Dr. Isaiah Bowman, president of the Johns Hopkins University.

Dr. Arthur H. Compton, Charles H. Swift distinguished service professor of physics, University of Chicago.

Dr. James B. Conant, president of Harvard University.

Dr. Edwin G. Conklin, emeritus professor of biology, Princeton University.

Dr. Luther Pfahler Eisenhart, professor of mathematics and dean of the Graduate School, Princeton University.

Dr. Herbert S. Gasser, director of the Rockefeller Institute for Medical Research.

Dr. Herbert C. Hoover.

Dr. Ernest O. Lawrence, professor of physics and director of the Radiation Laboratory, University of California at Berkeley.

Dr. Frank R. Lillie, professor of embryology emeritus, University of Chicago.

Dr. Robert A. Millikan, director, Norman Bridge Laboratory of Physics and chairman of the executive council of the California Institute of Technology.

Dr. Alfred N. Richards, professor of pharmacology, University of Pennsylvania.

Dr. William J. Robbins, director of the New York Botanical Garden.

Dr. Harlow Shapley, director of Harvard College Observatory and Paine professor of astronomy, Harvard University.

Dr. George H. Whipple, professor of pathology and dean of the School of Medicine and Dentistry of the University of Rochester.

Ex Officio: Dr. Frank B. Jewett, president of the National Academy of Sciences, New York City; Professor Ross G. Harrison, chairman of the National Research Council, Yale University; Dr. Irving Langmuir, president, American Association for the Advancement of Science, General Electric Company, Schenectady, N. Y.

The National Science Fund has been organized as the result of a three-year study of the present sources of financial support for fundamental research in science. Under the chairmanship of Dr. Albert F. Blakeslee, a committee of the academy with the aid of a grant from the Carnegie Corporation of New York recently completed a survey showing the need to develop additional funds for scientific research. The committee found that universities and foundations which in the past have been a main support of fundamental scientific research are finding it increasingly difficult to provide the necessary funds. Decreased earnings on endowments are steadily making their task harder. Although expenditures for scientific research by industry and by government have increased greatly

in recent years, this expansion has not covered, nor can it hope to cover adequately the fields of fundamental research which have derived support largely from other sources.

Dr. Jewett, in his announcement, pointed out that the National Academy of Sciences has a Congressional charter and thereby bears important public responsibilities. He said that as the welfare of science and the welfare of the nation are more and more intimately associated, the academy because of its prominent position in American science must assume leadership in preserving and advancing science in the Western Hemisphere. To this end, Dr. Jewett expressed the hope that the fund would establish a noteworthy reputation and in the future would attract gifts, both large and small, from people in all walks of life who wished to make public benefactions.

PRESENTATION OF THE HENRY DRAPER MEDAL OF THE NATIONAL ACADEMY OF SCIENCES TO DR. ROBERT WILLIAMS WOOD

THE Henry Draper Medal of the National Academy of Sciences was presented to Dr. Robert Williams Wood, research professor of experimental physics at the Johns Hopkins University, at the annual dinner of the academy on April 29, "in recognition of his contributions to astronomical physics."

A brief citation of the reasons for the award was given by Dr. Otto Struve, a member of the committee of the Henry Draper Fund, which made the recommendation, and the presentation was made by the president of the academy, Dr. Frank B. Jewett. Dr. Wood presented a paper before the academy entitled "Diffraction Gratings and Replicas for Astrophysical Research," an abstract of which appears in this issue of SCIENCE. The citation given by Dr. Struve follows:

By unanimous vote of the committee on the Henry Draper Fund of the National Academy of Sciences has recommended the award of the Draper Medal for distinguished contributions to physical astronomy to Dr. Robert Williams Wood, professor emeritus of experimental physics at the Johns Hopkins University. Professor Wood's contributions in the field of physics have been so many and varied, and so fruitful in their applications that no word at this time could add to the wealth of recognition which they have received.

In the field of astrophysics three important researches, among many others, stand out especially. The first is Wood's pioneer work on resonance radiation and its applications to solar and stellar spectroscopy. A second is his development and skilful use of absorption screens of many types for astronomical and spectroscopic photography. Finally, and perhaps more important of all for the future of astrophysics, are the remarkable advances he has made in the construction of diffraction gratings. Where the use of the grating to produce a spectrum has been limited almost wholly to the sun and to bright sources in the physical laboratory, Wood through selection and shaping of the point of his ruling diamond has succeeded in throwing as much as one half of the incident light into a chosen order of the spectrum. In addition he was the first to achieve excellent results in ruling gratings on films of aluminum evaporated on glass. As a result a modern Wood grating with high concentration of light is one of the most effective instruments of research in stellar spectroscopy. It has made possible the analysis of the spectra of the brighter stars on a large scale, has opened up the almost unexplored ultra-violet region of stellar spectra, and has already led to discoveries of interest regarding the constitution of the gases in interstellar space.

The capacity to develop valuable new methods and new instruments, the widening application of which no one can adequately foresee, is given to but relatively few men. Our medallist of to-day is certainly to be numbered within this chosen group.

ELECTIONS OF THE NATIONAL ACADEMY OF SCIENCES

ELECTIONS at the spring meeting of the National Academy of Sciences held in Washington on April 30 are:

Vice-president (for a term of four years): Dr. Isaiah Bowman, president of the Johns Hopkins University, to succeed Dr. Arthur L. Day, whose term expires on June 30.

Members of the Council (for a term of three years): Dr. S. A. Mitchell, Leander McCormick Observatory, University, Virginia, to succeed himself; Dr. E. B. Fred, University of Wisconsin, to succeed Dr. E. D. Merrill.

New Foreign Associates: Dr. Edgar Douglas Adrian, professor of physiology, University of Cambridge, and fellow of Trinity College; Dr. Archibald Vivian Hill, honorary professor of physiology at University College, London, and Foulerton research professor and secretary of the Royal Society, London; Sir Arthur Keith, Buckston Browne Farm, Downe, England.

New Members: Werner Emmanuel Bachmann, professor of organic chemistry, University of Michigan; René Jules Dubos, associate member of the Rockefeller Institute for Medical Research, New York City; Evarts Ambrose Graham, professor of surgery, Washington University, and chief surgeon, Barnes and St. Louis Children's Hospital; Arthur Scott King, superintendent of the physical laboratory, Mount Wilson Observatory; Charles Christian Lauritsen, professor of physics, California Institute of Technology, Pasadena; Alfred Lee Loomis, director, the Loomis Laboratories, Tuxedo Park, New York; J. Robert Oppenheimer, professor of physics, University of California, and California Institute of Technology; John Thomas Patterson, professor of zoology, University of Texas; Karl Sax, professor of botany, Harvard Univer-

sity; George Gaylord Simpson, associate curator of vertebrate paleontology, American Museum of Natural History, New York City; Joseph Slepian, research engineer, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.; Lyndon Frederick Small, head chemist of the Division of Infectious Diseases, National Institute of Health, U. S. Public Health Service; Wendell Meredith Stanley, member of the Rockefeller Institute of Medical Research, Princeton, N. J.; Tracy Yerkes Thomas, professor of mathematics, University of California at Los Angeles; George Bernays Wislocki, Parkman professor of anatomy at Harvard University.

SCIENTIFIC NOTES AND NEWS

FORMER students of Dr. Marston Taylor Bogert, professor emeritus of organic chemistry in residence at Columbia University, who had obtained the doctorate under his direction presented his portrait to the university at a dinner at which he was the guest of honor at the Chemists' Club on May 2. Frederic E. Coudert, university trustee, accepted the painting on behalf of Columbia, where Dr. Bogert has been a member of the teaching staff for forty-seven years. Dr. Michael Heidelberger, of the Columbia School of Medicine, made the presentation. Dr. George D. Beal, of the Mellon Institute of Industrial Research, Pittsburgh, was toastmaster. The speakers included Dr. Edward Bartow, of the Johns-Manville Corporation, vice-president of the International Union of Chemistry, of which Dr. Bogert is president; Dr. Robert M. MacIver, head of the Columbia University Section of the Association of University Professors; Dr. Henri Mouquin, of New York University, president of the Société de Chimie Industrielle; Dr. Charles L. Parsons, Washington, D. C., secretary of the American Chemical Society, of which Dr. Bogert is past president; Dr. Foster D. Snell, of Brooklyn, president of the Graduate Alumni Association of Columbia University; Dr. Maximilian Toch, past president of the Chemists' Club; Dr. Horatio B. Williams, of Columbia University, president of Sigma Xi; Dr. Lincoln T. Work, of the Metal and Thermit Corporation, Carteret, N. J., chairman of the American Section of the Society of Chemical Industry.

THE John Phillips Memorial Medal for 1940–41 of the American College of Physicians was awarded at the recent Boston meeting to Dr. William C. Stadie, associate professor of research medicine at the University of Pennsylvania, in recognition of his work on diabetes.

THE Thomas McCrae award of one hundred dollars for the best publication in 1940 by younger members of the Medical Staff of the Pennsylvania Hospital, Philadelphia, was granted to Dr. Robert F. Norris and Dr. Alexander Rush. At a special meeting on April 22, at which the awards were presented, Dr. Henry A. Christian, Hersey professor of the theory and practice of physics, emeritus, of Harvard University, made an address on "Scholarship in Medicine."

THE two awards of $100 each offered by the Laymen's League against Epilepsy in 1940 for the best original unpublished investigations bearing on the subject of epilepsy have been granted for work done in a state epileptic colony or mental hospital to Dr. Walter L. Bruetsch, Central State Hospital, Indianapolis, "Rheumatic Epilepsy," and for work done elsewhere to Dr. Frederick A. Fender, Stanford University Hospital, San Francisco, "Convulsions Following Remote Electrical Stimulation of Subcortical Cerebral Levels."

THE *Journal* of the American Medical Association states that Dr. Lewis Thomas, of the Neurological Institute, New York, has received the first research fellowship in neurology awarded by the Frederick Tilney Memorial. Dr. Thomas will begin his work in the field of infectious diseases of the central nervous system at the Thorndike Memorial Laboratory and the Boston City Hospital.

L. B. ROGERS has been awarded the J. T. Baker Chemical Company (Eastern Division) research fellowship in analytical chemistry for 1941–42. He will work at Princeton University under the direction of Professor E. R. Caley. Members of the fellowship committee making the award are: N. Howell Furman, *chairman,* Princeton University; John H. Yoe, *secretary,* University of Virginia; G. P. Baxter, Harvard University; H. A. Fales, Columbia University, and C. W. Mason, Cornell University.

DR. LEON W. COHEN, professor of mathematics at the University of Kentucky, has been named president of the university branch of the American Association of University Professors.

DR. C. E. NABUCO DE ARAUJO, JR., has been elected president of the Brazilian Chemical Association for the coming year.

AT the forty-first annual meeting of the American Association of Pathologists and Bacteriologists in New York on April 10 the following officers were elected for the ensuing year: *President,* Dr. Samuel R. Haythorn; *Vice-president,* Dr. Paul R. Cannon; *Secretary,* Dr. Howard T. Karsner; *Treasurer,* Dr. Alan R. Moritz; *Assistant Secretary,* Francis Bayless, and *Assistant Treasurer,* Dr. Granville A. Bennett. The next

annual meeting of the association will be held in St. Louis, on April 2 and 3, 1942. Half a day will be devoted to a symposium on "Neoplasms of the Endocrine Glands."

AT the recent meeting of the Indian Science Congress at Benares, the Indian Society of Genetics and Plant Breeding was inaugurated. The following officers were elected for the year 1941: *President,* Rao Bahadur T. S. Venkatraman; *Vice-presidents,* Dr. W. Burns, K. Ramiah; *Secretary,* Dr. B. P. Pal; *Treasurer,* Dr. S. Ramanujam; *Councillors,* Dr. V. K. Badami, Dr. B. S. Kadam, Dr. J. S. Patel and Dr. T. S. Sabnis. The society will publish a journal in which papers on genetics, plant breeding and cytology will be published.

PROFESSOR LEON BRILLOUIN, of the Collège de France, will be in residence at the University of Wisconsin as visiting professor of physics for some months beginning about May 7.

DR. CARL G. HARTMAN, of the department of embryology of the Carnegie Institution of Washington at the Johns Hopkins University, has been appointed professor of zoology and head of the departments of zoology and physiology at the University of Illinois, beginning on September 1. It is anticipated that in the near future the two departments will be united. Professor V. E. Shelford, who has been in charge of the department of zoology for the past two years, will continue his research with a reduced teaching load.

MISS SARAH GIBSON BLANDING, dean of women and associate professor of political science at the University of Kentucky, has been appointed director of the State College of Home Economics at Cornell University. She succeeds Miss Flora Rose. Miss Mary Henry, acting director since Miss Rose's retirement last October, will resume work as assistant director.

JAMES KIP FINCH, Renwick professor of civil engineering at Columbia University and since 1932 head of the department, has been made associate dean of the Faculty of Engineering.

DR. RAYMOND W. AGER, assistant professor of electrical engineering at the University of California, has been appointed associate professor of electrical engineering at Cornell University. He will join the faculty in July, and will have charge of the research and testing program in the new High-Voltage Laboratory. He will also give some of the senior courses in the School of Electrical Engineering. Dr. Samuel L. Leonard, of Rutgers University, has been appointed associate professor of zoology. Associate professors in the College of Agriculture, who have been promoted to the rank of full professor, are Leo A. Muckle, professor of extension service and assistant county agent leader, and Dr. Donald S. Welch, professor of plant pathology and forest pathologist in the Experiment Station.

DR. WILLARD E. HOTCHKISS, Maurice Falk professor of social relations at the Carnegie Institute of Technology, has been appointed director of a newly organized Division of Humanistic and Social Studies. The new division centralizes the responsibility for related types of studies, which have been offered in the College of Engineering chiefly under the Social Relations Program, and in the Margaret Morrison Carnegie College and the College of Fine Arts under the Division of General Studies.

DR. J. L. T. APPLETON has been appointed acting dean of the Dental School of the University of Pennsylvania.

FRANK MYERS, research fellow in the department of microscopy of the Academy of Natural Sciences of Philadelphia and research associate in Rotifera in the American Museum of Natural History, New York, has been elected a member of the board of trustees of the academy.

ARCHIE CRAMER, formerly research chemist on the staff of the Carnegie Institute of Technology, has joined the Miner Laboratories, Chicago, where he will conduct chemical research on soybeans.

DR. WARREN WEAVER, director of the Natural Sciences of the Rockefeller Foundation, and Edward J. Poitras, of the California Institute of Technology, returned to New York by clipper on April 28, having spent five weeks in England as members of the scientific mission appointed by President Roosevelt from the membership of the National Defense Committee. Dr. Weaver, Mr. Poitras, Professor Louis B. Slichter, of the Massachusetts Institute of Technology, and Dean John T. Tate, of the University of Minnesota, were together in London throughout the nine-hour bombing raid of April 16 and 17—the most severe London has experienced.

DR. CLARENCE A. MILLS, Heady professor of experimental medicine at the University of Cincinnati, is now in Panama where he is continuing work begun last year on the effects of tropical climates on man. He is working at the Gorgas Memorial Institute.

DR. TENG-CHIEN YEN, research associate of the Academia Sinica (National Academy of China), is spending some time in the Division of Zoology of the New York State Museum at Albany studying the Gould types of mollusca which form a part of the collections. Immediately preceding his recent arrival in Albany he had carried on his researches on the molluscs at the Philadelphia Academy of Natural Sciences.

DR. ROBERT J. TRUMPLER, professor of astronomy in the University of California, Berkeley, delivered an Alexander F. Morrison lecture of the Astronomical Society of the Pacific at the University of California, Los Angeles, on the evening of April 23. The subject of the lecture, which was illustrated with slides, was "The Milky Way."

DR. DANIEL J. GLOMSET, Des Moines, Iowa, gave the seventeenth Ludvig Hektoen Lecture of the Frank Billings Foundation before the Institute of Medicine of Chicago on April 25. His subject was "Observations on the Structure of the Cardiac Conduction System in Man and Other Mammals."

DR. REBECCA C. LANCEFIELD, associate of the Rockefeller Institute for Medical Research, will deliver the eighth and last Harvey Society lecture of the current series at the New York Academy of Medicine on May 15. She will speak on: "Specific Relationship of Cell Composition to Biological Activity of Hemolytic Streptococci."

BY invitation of the three leading educational institutions of Flagstaff, Ariz., the Museum of Northern Arizona, the Arizona State Teachers College and the Lowell Observatory, the Society for Research on Meteorites will hold its eighth meeting in that city on June 23, 24 and 25. A feature of this meeting will be an excursion to the great Canyon Diablo Meteorite Crater, some forty miles east of Flagstaff.

THE Philadelphia Chapter of the American Society for Metals will hold on May 16 and 17 a Conference on the Hardening of Metals in the John Harrison Laboratory of Chemistry of the University of Pennsylvania.

THE nineteenth annual conference of the Milbank Memorial Fund was held on April 29 and 30 at the New York Academy of Medicine. The discussions were devoted to health problems in national defense, nutrition in the defense program and reports on factors influencing fertility. The conference was divided into three panels of which Dr. G. Canby Robinson, of the Johns Hopkins University; Dr. Frank G. Boudreau, executive director of the Milbank Memorial Fund, and Dr. Lowell J. Reed, dean of the School of Hygiene and Public Health at the Johns Hopkins University, were chairmen. Dr. C.-E. A. Winslow, professor of public health at the School of Medicine of Yale University, presided at the annual dinner on April 30. The guest speaker at the dinner was Dr. Thomas Parran, Jr., Surgeon General of the U. S. Public Health Service. Albert G. Milbank, president of the fund, and Dr. Boudreau also spoke.

THE summer meetings of the Genetics Society of America will be held at Cold Spring Harbor, New York, from August 27 to 29. Facilities of the Biological Laboratory of the Long Island Biological Association and of the Department of Genetics of the Carnegie Institution of Washington will be available for the meetings. The proposed program includes an evening lecture by Professor A. H. Sturtevant on "Comparative Genetics of the Species of Drosophila," and one or two sessions devoted to the informal type of demonstration presentation that has characterized the program of the society in recent years. Opportunity will be offered for inspection of the work of the Carnegie staff and of the investigators who will be in residence at the Biological Laboratory during the summer. Among these exhibits will be the garden plots showing a series of representative types of Daturas and other plants which have been developed in the Carnegie Laboratories during recent years. Visitors desirous of attending the meetings are urged to notify the secretary, B. P. Kaufmann, or the local representative, J. S. Potter, Department of Genetics, Carnegie Institution of Washington, at least one week in advance so that housing facilities may be arranged.

THE Animal Nutrition Laboratory of Cornell University has been granted $60,000 by the Rockefeller Foundation to continue its research concerning degenerative diseases and age changes. According to the provisions of the gift, it is to be an "outright grant for researches under the direction of Professor Clive M. McCay for the Laboratory of Animal Nutrition, primarily those on aging and longevity." A long-range research program will be set up with the new funds, which will provide experimental material for specialists at Cornell University and other institutions concerned with degenerative diseases and age changes.

BY the will of Henry Osborn Taylor, distinguished for his work on the history of civilization, who died on April 13 at the age of eighty-four years, his residuary estate of undetermined value is bequeathed to Harvard College to increase the salaries of the professors and instructors there. The income from this gift is to be made part of the "Julia Isham Taylor Fund" established as a memorial to Mrs. Taylor. In addition to works of art, Harvard College also will receive eventually a trust fund of $50,000.

THE National Advisory Cancer Council of the U. S. Public Health Service, has recommended the following grants: Meharry Medical College, Nashville, Tenn., $1,100 for the maintenance of clinical cancer records for research; Jackson Memorial Laboratory, Bar Harbor, Me., $15,000 for research in the genetics of cancer; Barnard Free Skin and Cancer Hospital, St. Louis, Mo., $5,000 for research in the integration of changes in experimental carcino-genesis; the University of California, $600 for research on the urinary gonadotropic hormone coincident with testicular neoplasms.

IT is reported in *Nature* that the Government of Eire has set up a small advisory body, to be known as the Emergency Scientific Research Bureau, to deal primarily with the technical problems involved in the provision of substitute processes and materials during the period of the emergency. This body, which will be attached to the Department of the Taoiseach, has the following terms of reference: (1) To give technical advice to the Government on such special problems relating to industrial processes and the use of substitute materials as may be referred to them. (2) To advise the Government generally on the use of native or other materials to meet deficiencies caused by the restriction of imported raw materials and commodities. (3) To direct or conduct special researches and inquiries connected with the above. The following have been appointed members of the bureau: Dr. J. J. Dowling (*chairman*), professor of technical physics, University College, Dublin; Dr. J. J. Drumm; Dr. M. A. Hogan, professor of mechanical engineering, University College, Dublin; Dr. J. H. J. Poole, professor of geophysics and experimental physics, Trinity College, Dublin; Dr. T. S. Wheeler, state chemist. The secretary to the Industrial Research Council, Dr. J. J. Lennon, will act as secretary to the bureau.

DISCUSSION

BOULDER DAM INVESTIGATIONS: SIGNIFICANCE OF EXPERIMENTAL DATA

ENGINEERS and scientists throughout the world have looked forward for many years to the publication of the technical reports on the researches and investigations which were carried out prior to the construction of Boulder Dam, completed in 1935. The U. S. Bureau of Reclamation has recently published their report on "Thermal Properties of Concrete." This is one of a series of 37 *Bulletins* which will cover all phases of the Boulder project; it is the first to give the results of laboratory work on concrete. The *Bulletin* gives the details of experimental studies of the conductivity and specific heat of concrete at temperatures ranging from 50 to 150° F. The purpose of these studies was to furnish information for use in designing and operating a refrigeration system for removing the heat developed by hydration of the 663,000 tons of Portland cement used in the dam.

Concrete sets and hardens as a result of chemical reactions between the compounds in the cement and the mixing water. Each gram of cement evolves 50 to 90 calories of heat during the first week. In small sections this heat is gradually dissipated to the atmosphere, hence there is no abnormal rise in temperature; however, in large masses, especially if the concrete is placed rapidly, as in concrete dams, the internal temperature will rise 50 to 75° F., unless measures are taken to remove part of the heat generated by the hydration of the cement. Abnormal rise of temperature causes a volumetric expansion of the concrete, which sometimes disrupts the mass; at best it is objectionable due to the shrinkage which occurs when the concrete finally cools.

The situation at Boulder Dam was aggravated by the high summer temperatures—mean for July 108° F. The methods adopted consisted of (a) using a low-heat-of-hydration cement and (b) embedding hundreds of miles of steel pipe in the dam through which artificially cooled water was circulated. The *Bulletin* does not give information on the larger question of how successful these measures were in solving the problem of temperature control in Boulder Dam.

An elaborate apparatus was devised for the laboratory studies of the thermal properties of concrete; many observations were made of temperature, weights and lengths, as well as in electrical units. The theoretical phases of the subject are developed by the use of differential equations and Bessel functions. The *Bulletin* is marred by numerous errors of statement and proofreading. A notable feature is the failure to recognize the limitations of experimental data. The Bureau scientists apparently missed two important principles: (1) That the results of arithmetical operations are never more precise than the least precise value which enters into the computation; (2) that an experimental value can not be more precise than the least precise data on which it is based. Item (2) is, of course, only an application of (1).

Under "Computations of Conductivity" (p. 110) 15 2-place and 19 3-place factors are introduced in dealing with the fundamental data. Needless to say, it is absurd to compute values from these data to 4, 5 or 6 significant figures, as was done by the authors.

Conversion factors, to be used with the 2- or 3-place data, are given to 8 significant figures; for example, the factor 0.256,065,03 is given (p. 41) for converting diffusivity values from English to metric units.

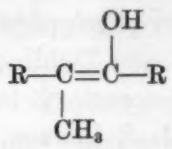
In spite of the appearance of great refinement, these 4-, 5- and 6-place computed quantities are only *2-place values*. These computed values wear the cloth but not the clothes of accuracy. The methods of this *Bulletin* are analogous to measuring with one's thumb, then computing the length to the nearest ten-thousandth of an inch.

DUFF A. ABRAMS

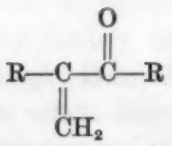
NEW YORK, N. Y.

THE SEARCH FOR A STABLE SUBSTITUTED VINYL ALCOHOL

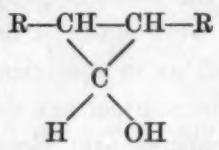
FOR a long time chemists[1] have been attracted by the possibility of preparing a stable substituted vinyl alcohol. Recently Fuson, Corse and McKeever[2] had reason to believe that they had finally reached that goal. Their compound I (M.P. 126–7° C) to which they assign the structure



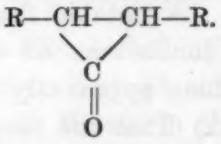
(where R is mesityl) resulted from catalytic hydrogenation of a compound II (M.P. 131.5–133° C) considered to be



but for which no structure proof was given. The compound I, however, has such a high stability for an enol that one is tempted to consider other possible structures for it. It occurred to me that it might be



and compound II the corresponding ketone



These structures are not incompatible with the observed behavior. If such a relationship exists between these two compounds then it should be possible to oxidize compound I to compound II. This was found to be the case. Fifty mgs of compound I (M.P. 126–127.5° C) on treatment for three hours with an equimolar amount of chromic acid in acetic acid yielded 20 mgs of a crystalline compound of M.P. 132.5–133.5° C which by the mixed melting point method proved to be identical with compound II of the same melting point. Catalytic reduction of this oxidation product regenerated compound I. Such behavior on oxidation is difficult to reconcile with the vinyl alcohol formula without assuming an unprecedented 1,4 dehydrogenation. On the other hand, no claim is made at this time for the correctness of the cyclopropanol structure. It is offered merely as a possibility not readily eliminated by available data. This experimental work does suggest, however, that it might be wise to accept the vinyl alcohol structure with some reserve until further evidence in its support is forthcoming. If this enol formula can be definitely established by its sponsors they will have made a valuable contribution to the subject.

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[1] Claisen, *Ber.*, 25: 1781, 1892; Biltz, *Ann.*, 296: 242, 1897, *Ber.*, 32: 650, 1899; Kohler, *Am. Chem. Jour.*, 36: 177, 1906; Tiffeneau and Daufresne, *Compt. rend., Acad. d. Sci.*, 145: 628, 1907; Wislicenus and Waldmüller, *Ber.*, 42: 785, 1909. See claims of Grignard and coworkers, *Compt. rend., Acad. d. Sci.*, 179: 1573, 1924, 182: 422, 1926; *Bull. Soc. Chim.* [4] 49: 23, 1931, and refutation by Kohler and Thompson, *Jour. Am. Chem. Soc.*, 55: 3822, 1933, and Hückel and Radszat, *Jour. prakt. Chem.*, 140: 247, 1934; Kohler, Tishler and Potter, *Jour. Am. Chem. Soc.*, 57: 2517, 1935; Kohler and Thompson, *ibid.*, 59: 887, 1937.

[2] Fuson, Corse and McKeever, *Jour. Am. Chem. Soc.*, 62: 3250, 1940.

THE ANTICANITIC VITAMIN

OF the findings in vitamin studies that have come into recent prominence none is of more esthetic interest than the condition described by Morgan, Cook and Davison[1] as occurring in rats. The graying of hair in experimental animals is now thought to be cured by a substance whose chemical nature is little understood and which is often called colloquially "the anti-gray hair factor." A similar syndrome in rats,[2] of economic importance in the rearing of silver foxes,[3] was recognized by Lunde and Kringstad in Norway. As the term "anti-gray hair factor" popularizes the curative and prophylactic attributes of the responsible substance or substances, the use of such a designation does not seem desirable.

A name to meet this objection has been advanced; namely, "anti-achromotrichia factor." But this term tends to make scientific terminology more complex than necessary and hence a simpler name is needed. The writer prefers the neonym "anticanitic vitamin" that will be easily understood by biochemists, members of the medical profession and other scientists. *Canitic* is derived from canities (Latin *canus* = white), meaning "the turning gray of the hair," and its employment as indicated was proposed by Dr. W. A. Hamor[4] of Mellon Institute.

The aim of the present communication is merely to report this new descriptive term and to propose the cooperation of others in using it, especially in medical literature. As yet the nutritional significance for human beings of the anticanitic vitamin, if it is needed at all, remains to be established by further work.

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[1] Agnes F. Morgan, Bessie B. Cook and Helen G. Davison, *Jour. Nutrition*, 15: 27–43, 1938.

[2] G. Lunde and H. Kringstad, Avhandl. Norske Videnskaps Akad. Oslo. I Mat. Naturv. Klasse 1938, No. 1, 17 pp. *Chem. Abstracts*, 32: 5456–7, 1938.

[3] G. Lunde and H. Kringstad, *Saertrykk av Norsk Pelsdyrblad*, 13: 500–4, 1939.

[4] *Nutritional Observatory*, 1: No. 3, 1941.

REGARDING FSH AND LH

IN the January 17, 1941, issue of SCIENCE, Coffin and VanDyke propose the names thylakentrin and metakentrin for the anterior pituitary follicle stimulating and luteinizing hormones. It would seem preferable that the preparation of a purer product not be made the occasion for renaming these hormones, but that they be renamed by their chemical structure if it is ever known or only after the fundamental action of each is known. When that time comes the terminations "trophic" or "kinin," with usage already established, may well be found to be appropriate.

The follicle stimulating hormone might then appear under some such new name as gametokinin, or gametotrophic hormone, the luteinizing under some short name signifying sex-hormone-generator.

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SCIENTIFIC BOOKS

TUBERCULOSIS

Studies on Tuberculosis. The Spread of Tuberculosis in Negro Families of Jamaica, B. W. I. By E. JOYCE SAWARD, PERSIS PUTNAM and EUGENE L. OPIE. *The Fate of Negro Persons of a Tropical Country, Jamaica, B. W. I., after Contact with Tuberculosis.* By EUGENE L. OPIE, PERSIS PUTNAM and E. JOYCE SAWARD. *A Survey of Tuberculous Infection in a Rural Area of East Alabama.* By A. H. GRAHAM, P. W. AUSTON and PERSIS PUTNAM. *The Fate of Persons Exposed to Tuberculosis in White and Negro Families in a Rural Area of East Alabama.* By A. H. GRAHAM, P. W. AUSTON and PERSIS PUTNAM. Pp. 198. Baltimore: The Johns Hopkins Press, 1941.

As the magnitude of the total tuberculosis problem declines, with the lessening general death rate from this disease, certain concentrations of mortality become increasingly conspicuous. Most prominent in this perspective is the severity of tuberculosis in Negroes. The excessive Negro mortality has been repeatedly investigated. The two causes on which greatest stress has been laid are a genetic inferiority in resistance to tuberculosis as compared with the white race and the Negro's relatively unfavorable social and economic environment.

The authors of the monograph here reviewed have approached the problem from the latter point of view. The facts and figures recorded are impressive in their own significance, but doubly so in view of the basis established by a long series of studies by the same and associated authors, in past years.

The investigations on which the monograph is based were aided by grants from the International Health Division of the Rockefeller Foundation, made over a period of approximately fifteen years to Opie and his associates for studies in Philadelphia, Jamaica and Alabama in communities suitable in environment and existing facilities for comparison of the course of tuberculosis in whites and Negroes.

The spread of tuberculosis through intimate association of the sick and the well is the core of the tuberculosis public health problem. Previous studies by Opie and McPhedran in the same general series of papers as the one here under consideration led to the conclusion that "the spread of tuberculosis occurs in large part by long drawn-out family or household epidemics in which the disease is slowly transmitted from one generation to the next." All those conditions favoring household spread of tuberculosis to which Opie and his colleagues have drawn attention in previous papers, are exaggerated in the Negro race, and especially so in Negroes in the environments selected for special study. Poverty and crowding, with abundant opportunity for spread of disease, were maximal in the poor quarters of Kingston, Jamaica, where members of 1,100 families were under observation in a tuberculosis clinic. As a whole, the environment from which the patients came was characterized by "unhygienic housing conditions, uncleanly habits and lack of facilities for segregation of those who suffer with the disease." Under the conditions rapid spread of the disease within households was the rule.

Two features of Negro tuberculosis brought out in this and in previous studies are the great number of tubercle bacilli in the sputum in Negro patients and the rapidity of progression of serious disease. The latter is of important epidemiological significance, for it means a much smaller number of living cases in proportion to annual deaths in the Negro than the white race. Apparently maximal spread of the disease coincided with its latest stages. The Alabama papers speak of an "explosive" attack rate in families after a death from tuberculosis.

The attack rate in this series of studies has shown a constant relation to the age at which exposure commenced. Analysis by groups on the basis of age at the time of first exposure in the home showed that a prompt rise in the number of cases of tuberculosis occurs in all age groups following contact with tuberculosis. The chief purpose of the analysis was to determine if exposure of adults leads to immediate evidence of infection, just as it does in children. The

affirmative answer constitutes a strong argument for the view that the tuberculosis of adults is exogenous.

The study thus throws new light on two of the most debated problems in the whole field of tuberculosis investigation, *viz.*, the cause of the Negro's high mortality and the relative importance of endogenous and exogenous infection in adults. The close relation between intensity of exposure and frequency of onset of tuberculosis emphasized the rôle of environment as the chief factor responsible for the Negro's excessive rate. The prompt rise in incidence following exposure in adult years furnishes an almost incontrovertible argument for exogenous rather than endogenous infection as the basis for the bulk of the tuberculosis of adult life in the population studied.

The reader is left with certain questions still in mind on the character of Negro tuberculosis. The excessive number of bacilli in the sputum, the unusual intensity of the tuberculin reaction as compared with that observed in white patients and the high proportion of lesions of the "childhood type" in Negroes of adult years in a population almost universally infected by the age of ten years, can hardly be explained on the basis of environment alone. In the present series of papers the authors have not attempted an explanation of these phenomena. The record in the respects indicated is limited to the objective presentation of facts.

The papers will be of lasting value for the science of epidemiology. In addition they indicate a practical basis of operation in programs of tuberculosis control in Negroes. The statistical methods employed and the family graphs presented make perfectly clear the gravity of exposure and the results likely to follow under a given set of circumstances. The book should be studied by every public health officer dealing with the problem of Negro tuberculosis.

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ELECTRICAL ENGINEERING

Principles of Electrical Engineering. By WILLIAM H. TIMBIE, professor of electrical engineering and industrial practice, Massachusetts Institute of Technology, and VANNEVAR BUSH, president of the Carnegie Institution of Washington. Third edition. 540 pages, 388 figures. New York. John Wiley and Sons, Inc. 1940. (There is a supplementary paper-bound booklet containing the answers to the 649 problems which are distributed throughout the textbook.)

THIS book describes clearly and simply the fundamental experimental and theoretical bases of electrical engineering. Following an elementary qualitative discussion of the Rutherford-Bohr-Summerfeld theory of atoms: the principles of direct-current circuits, the magnetic circuit, induced electromotive forces, forces on conductors, electric fields, electronics, conduction in solids and liquids, and electrodynamics are discussed briefly with particular emphasis upon their implications in electrical engineering. The authors presume that students who use their book will have studied courses in elementary algebra, trigonometry and differential and integral calculus, and a general introductory course in physics. Although the material of the text is necessarily developed from mathematical physics, the emphasis is everywhere, and particularly in the problems, upon those aspects of mathematical physics that are relevant to electrical engineering.

The authors have chosen their material and the methods of presenting it with the guiding criterion that the book shall be practically useful from the student's point of view. Thus the mathematical derivations are detailed but simple; the qualifications and limitations of the elementary theories are briefly stated and the student is referred to other books for a detailed account of them. The book is therefore comprehensive without being complicated. The authors have included references to the original classic works of such men as Ampere, Faraday and Maxwell.

The Theorem of Superposition, Thevinin's Theorem and equivalent circuits are introduced in an elementary manner in the chapter (IV) on "The Simplification of Electric Networks." The extension of these ideas to alternating-current networks is not discussed, nor is there any discussion of the conventional tricks, such as the use of complex numbers, for solving steady-state alternating-current problems.

In the chapters on electric and magnetic fields the authors have not used vector notation. In many cases it would appear that the introduction of elementary vector concepts with their symbols would have made these discussions more simple and more clear.

The perspicacity of the authors of this excellent text-book is epitomized by two sentences which they wrote nearly twenty years ago in the preface to the first edition—"The subjects of thermionic emission, conduction through gases, electrolytic conduction, and certain high-frequency phenomena have been included. A knowledge of these matters is becoming more and more essential to the electrical engineer in any field." The progressive attitude symbolized by these statements has guided the authors in their preparation of this, the completely revised third edition of "Principles of Electrical Engineering."

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REPORTS

WORK OF THE NATIONAL RESEARCH COUNCIL OF CANADA

RESEARCH in Canada, in war as in peace, is an "essential" industry. To an increasing extent Canadian industry to-day is looking to the National Research Council for technical guidance and for cooperative assistance in the solution of their plant, engineering and processing problems. Even more important is the fact that in Canada the Departments of National Defense, of Munitions and Supply, of Transport and the numerous technical missions in the Dominion, use the National Research Council much as large industries use their affiliated research and engineering institutions. Facilities in the council's laboratories have been expanded as required to cope with the growing volume of work as the war has progressed. Committees have been appointed to take charge of highly confidential and secret work, in which category a large part of the council's current activities now belong.

The aeronautical laboratories are used to determine the practicability of new designs of aircraft and engines, improvements in technique in construction and flight, studies in engine performance and the effects of modifications in fuels and lubricants, the design and testing of skis and floats, the checking and repair of aircraft instruments. Tests of aviation gasoline, lubricating oil and other petroleum products for the Department of National Defense, have increased by about 250 per cent. as a result of the war.

A committee on aviation medical research has been established. Tests are being investigated for the selection of air crew men and the tests developed have already been found of great value in the selection of pilots, observers and gunners. High altitude flying not only presents problems in equipment but involves conditions which have a pronounced effect on the flying personnel. Another committee, formerly headed by Sir Frederick Banting and including representatives of the medical organizations and medical schools throughout Canada, is working in close cooperation with the British Medical Research Council. Special problems have been assigned to Canadian scientists and the result of their work is being made available to the Empire's Armed Forces. Great progress is being made in the reduction of infection of war wounds which took such a heavy toll in the last war.

Feeding of the troops presents a most important problem. The Division of Biology and Agriculture cooperated in the preparation of the new ration schedule for the troops in Canada. Studies on the improvement and standardization of the food value of canned products are under way. New ways of stacking stored products and improved methods of forcing air through storage room stacks have been developed. Canadian bacon is ordinarily shipped to England in the pale or unsmoked condition. Since smoking prior to shipment would improve the keeping quality during shipment or subsequent storage, an experimental smoke oven has been constructed to study this problem.

Forest tree breeding is carried on in close cooperation with the Dominion Forest Service and the Department of Agriculture. Several hundred hybrid poplars have been produced in a search for improved species for use as pulpwood, match wood and for windbreaks on the Prairies. Many of these hybrids are very fast growing.

In the chemical laboratories work is being carried on in cooperation with similar laboratories and committees in England, on defensive chemical warfare methods. The Division of Chemistry is working almost exclusively in a cooperative way with departments of government on the testing of supplies and the preparation of specifications. Textiles, leather, colloids, paints, laundering, metal spraying and bonding of rubber to metal are among the subjects on which testing techniques have been worked out and advice given on specifications so that the purchasing of supplies may be put on a sound scientific basis. Research on the production of metallic magnesium has taken on new significance, magnesium being an important metal in aircraft construction. Canadian raw materials have been found well suited to the production of this metal.

In the textile laboratory specifications have been prepared for a number of materials such as tarpaulins, camouflage nets, linings for bullet-proof helmets, cotton summer uniforms for the Navy, Army and Air Force and the extent to which cotton or other types of fibers could be substituted for linen, as, for example, in the case of parachute harness webbing, has been investigated.

The paint research laboratory is cooperating with government authorities and with manufacturers to facilitate the supply of the new highly specialized coatings. The rubber laboratory has continued work on the bonding of rubber to metal which has been widening to include the bonding of latex and synthetic rubber.

Work in the plastics laboratory has consisted largely of minor investigations and test work on a variety of plastics and a major investigation dealing with the use of various plastics and synthetic resins in aircraft construction. A program of test work on leather samples from the Department of National Defense has been carried on in cooperation with the Ontario

Research Foundation. Hundreds of samples from shoe factories engaged in military contracts have been examined. Specifications on shoe leathers have been suggested.

Corrosion studies have been extended to corrosion testing of underwater paints, metals and wire screening for radio equipment, corrosion resistance of certain metals used for construction of boat hulls, effect on metals of lubricating oils, and the corrosion of metals by domestic tap waters and by softened laundry waters.

In the Division of Physics and Electrical Engineering equipment has been developed for measuring the vibration characteristics of various aircraft. Useful results have been obtained. Experiments on defrosting aircraft propellors have shown that the method is likely to be applicable to service conditions. Equipment had been developed and constructed for war purposes in the following connections: (a) penetrometers for use in gas warfare (b) a chronograph for measuring muzzle velocities of guns (c) an electrical plotting device for sound ranging. Numerous tests have also been made on the armoring properties of various materials and work is in progress on the improvement of anti-aircraft projectiles. Fifteen new designs of electric meters or metering apparatus were examined and approval recommended. Investigations have proceeded on the use of Adcock aerials for long wave direction finding especially on imperfect sites and also for short wave direction finding. Extensive experiments have been carried out to determine a method of testing vapor barriers in walls. Considerable work has been done on a by-pass method of control on the heat supply in railway refrigerator cars.

In cooperation with the Department of Agriculture and the Division of Biology and Agriculture about two thousand determinations of minor elements in plant and animal material have been made by spectroscopic methods. In the sound laboratory work includes studies on the cause of flutter in gas mask valves, investigations of special telephone receivers for naval use and other new devices.

Extensive investigations of x-ray methods of inspection of castings, forgings, welds and other war materials have been continued and inspection methods and technique suitable for Canadian requirements have been developed. A small optical shop was established to experiment with various methods of producing precise optical devices and to produce certain precise optical parts for the repair of standard instruments and for the development of new equipment. A vast amount of intricate and detailed planning of heavy electrical machinery down to the smallest modern device is being carried on by the electrical engineering staff.

At the outbreak of the war representatives of the National Research Council, the Ontario Research Foundation and the Dominion Arsenal conferred with representatives of the British Purchasing Mission on the subject of munitions gauges. A gauge laboratory was gradually staffed and equipped at Ottawa and equipment was supplied to a similar laboratory set up by the Ontario Research Foundation at Toronto. Canadian manufacturers have shown an aptitude for the production of fine precision parts that bids fair to render Canada independent of outside supplies.

The National Research Council is making a substantial contribution to Canada's war effort.

SPECIAL ARTICLES

DIABETES AND INFLAMMATION[1,2]

THE condition of diabetes mellitus is known to become markedly intensified when complicated by inflammation or infection. No satisfactory explanation has ever been offered to account for the basic mechanism involved. The inflammatory reaction tends to be concomitantly increased in severity and there seems to exist a lowered resistance to infections. There are some observations indicating a diminished capacity for antibody production and a reduction in the bactericidal power of the blood.[3] The present observations attempt to explain both the enhanced degree of diabetes and the associated increased severity of the inflammatory reaction in diabetic dogs having a superimposed acute pleural inflammation.

All observations were made on dogs rendered diabetic by pancreatectomy. It is to be recalled in this connection that although this type of diabetes has many obvious points of similarities with the human form, nevertheless there are several points of differences.[4] Three groups of animals were studied as follows: (1) dogs having a pleural inflammation induced by the introduction of 1.5 cc of turpentine; (2) depancreatized dogs with a pleural inflammation induced by the same irritant, but receiving no insulin immediately preceding and during the period of inflammation; (3)

[1] Aided by grants from the Dazian Foundation for Medical Research, The International Cancer Research Foundation and the Milton Fund of Harvard University.

[2] The author had the assistance of Mr. M. A. Kadish. In the course of this study aid was also received from Miss Irene Lapouse and from Miss Joan Malkenson.

[3] R. Richardson, *Jour. Clin. Invest.*, 12: 1143, 1933; 19: 239, 1940.

[4] C. N. H. Long, Harvey Lectures, 1936–1937, p. 194, Williams and Wilkins Company, Baltimore.

depancreatized dogs with pleural inflammation but receiving repeated injections of low doses of insulin (8 to 10 units twice daily) throughout the period of study.

The presence of an acute inflammation in the right pleural cavity of dogs fails to alter the blood sugar level. On the other hand, a similar injurious reaction in a diabetic dog induces a sharp and rapid ascendency in the blood sugar from an average in the 8 dogs studied of 253 milligrams to a level of 469.1 milligrams per 100 cc. The experimental findings wholly substantiate the well-known clinical picture of a diabetic disorder complicated with infection.

What is the basic mechanism involved to explain the enhanced diabetes? There are two considerations which must first of all be borne in mind. In the first place, an inflamed area is a focus of proteolysis. This has been pointed out previously by a number of investigators including the writer.[5] The conspicuous protein catabolic process may be regarded as a cardinal feature of the inflammatory reaction. In the second place, the earlier studies, particularly of Lusk and of his school, have demonstrated that amino products of protein degradation are in the diabetic organism readily converted into sugar.[6,7] Gluconeogenesis from proteins is thus a well-recognized process. It is therefore quite possible that an inflamed area in the diabetic behaves as a focus of enhanced proteolysis, favoring thus the formation of glucose from protein breakdown; the glucose, in turn would gradually diffuse into the circulation. The accentuated degree of proteolysis would offer at the same time a reasonable explanation for the increased severity of an inflammatory reaction in diabetes. Studies were therefore carried out on both exudate and blood samples of diabetic and non-diabetic dogs to determine the degree of proteolysis at the site of an acute inflammation. Besides measuring the sugar and lactic acid, determinations were also performed on the total proteins, non-protein nitrogen, urea and amino acid nitrogen concentrations of both exudate and blood.

The results of the determinations on exudates substantiate the view that the inflamed area is an active focus of gluconeogenesis originating from increased protein breakdown. The lactic acid and sugar levels of diabetic exudates are considerably higher than encountered in non-diabetic exudates. The average increase in lactic acid is 52 per cent., while the increase in exudate sugar averages 473.6 per cent. There is a slight drop in total proteins averaging 12.56 per cent. The rise in the products of proteolysis in diabetic exudates is striking. The non-protein nitrogen is increased 89.45 per cent.; the urea, 126.3 per cent.; and the amino acid nitrogen, 74.29 per cent. These facts therefore indicate an enhanced degree of proteolysis at the site of inflammation in a diabetic animal. That these products of protein breakdown are converted to glucose by deamination is further substantiated by insulin administration. Repeated injections of this substance to depancreatized dogs with inflammation are followed not only by a drop in lactic acid and sugar concentration but also by complete inhibition of the enhanced local proteolytic processes. The total proteins, NPN, urea and amino acid nitrogen are now restored to the levels found in exudates of non-diabetic animals.

The enhanced glucose formation from proteins in the acutely inflamed area allows for the gradual penetration of this diffusible substance into the circulation. Not only is the level of blood sugar, as pointed out above, markedly raised; but there is also a pronounced rise in the concentration of non-protein nitrogen, urea and to some extent of amino acid nitrogen in the systemic circulation. This state of affairs is not referable to pancreatomy *per se*. The reflection in the blood stream of the rise in a diabetic exudate of intermediary products of carbohydrate and protein metabolism does not contradict the earlier observations of the writer on the fixation or localization of material at the site of inflammation; for, as he has pointed out, particles of smaller dimensions, and of greater diffusibility are less effectively retained in such foci. Such materials therefore gradually find their way into the circulating blood.[5,8] Inflammation *per se* in non-diabetic dogs fails to induce in the blood any increase in either protein or carbohydrate products of metabolism. Insulin administration by inhibiting gluconeogenesis from proteins at the site of inflammation likewise induces no detectable changes in the levels of the blood.

Finally, the enhanced local proteolysis in the inflamed area of a diabetic animal manifests morphological signs of cellular injury in the form of vacuolized, degenerated, and in many instances unidentifiable polymorphonuclear leukocytes. The cells studied were from areas of inflammation of several hours' to one day's duration. Comparable studies of non-diabetic exudates revealed normal appearing leukocytes. In agreement with earlier studies by the writer the character and type of the cells in exudates were found to be correlated with the pH and the lactic acid concentration.[9,10] Both the hydrogen ion and the lactic acid concentrations were found to be elevated in exudates of diabetic animals.

[5] Valy Menkin, "Dynamics of Inflammation," Macmillan Company, 1940. New York.

[6] P. G. Stiles and G. Lusk, *Am. Jour. Physiol.*, 9: 380, 1903.

[7] G. Lusk, "The Science of Nutrition," W. B. Saunders Company, 1923, Philadelphia.

[8] Valy Menkin, *Physiol. Rev.*, 18: 366, 1938.

[9] Valy Menkin, *Am. Jour. Path.*, 10: 193, 1934.

[10] Valy Menkin and C. R. Warner, *Am. Jour. Path.*, 13: 25, 1937.

In conclusion, the mechanism of enhanced diabetes with inflammation seems to be referable to an increased proteolysis in the inflamed area. The rise in protein breakdown processes is correlated both with gluconeogenesis, and with increased severity of the inflammatory reaction. The surplus glucose formed locally gradually diffuses into the circulation thus elevating markedly the blood sugar level. These studies will form the subject of a detailed forthcoming report.

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THE ACTION OF CRYSTALLINE PEPSIN ON HORSE ANTI-PNEUMOCOCCUS ANTIBODY

WE have recently shown that when diphtheria antitoxic pseudoglobulin is treated with crystalline pepsin, a cleavage of the antitoxin molecule occurs in a plane normal to the long axis and that all the reactivity remains with one fragment only.[1] We have now extended this study to horse anti-pneumococcus antibody digested with pepsin in acetate buffer at pH 4.5 according to the method of Grabar.[2]

Euglobulin fractions from several different horses containing Type I and Type II antibody[3] have been examined in the standard Svedberg oil-turbine ultracentrifuge. The different serums showed wide variations in the sedimentation constants observed in agreement with the experience of other workers.[4] Thus, for example, most of the antibody euglobulin from Type I serum No. 721–34 was concentrated in a component with $s_{20} = 7 \times 10^{-13}$ cm/sec/dyne, and relatively little heavier material was present. On the other hand, a euglobulin fraction from Type II antiserum No. 513–50 showed major components with $s_{20} = 7$, 11, 18 and 30×10^{-13} cm/sec/dyne; and specific absorption of the latter with SII indicated that the antibody was concentrated mainly in the three heaviest components. Both these preparations were among those digested with pepsin. The digested antibody was precipitated with specific polysaccharide and the specific precipitate dissociated with sodium chloride.[5] The purified, digested and dissociated antibody combines with twice as much polysaccharide per milligram antibody nitrogen as the normal antibody, in confirmation of Grabar[2] and Treffers and Heidelberger.[6] Its sedimentation constant is 5.2×10^{-13} cm/sec/dyne, suggesting a molecular weight of less than 100,000, and it is homogeneous as regards sedimentation behavior. The same sedimentation constant is obtained after pepsin treatment, regardless of the molecular weight of the antibody in the original starting material. The digested horse pneumococcus antibody combines with as much carbohydrate per milligram antibody nitrogen as normal rabbit pneumococcus antibody, and it is smaller in size.

Finally, it may be noted that digested horse pneumococcus antibody is more soluble in distilled water than is the untreated antibody, and it has been possible to utilize this property to facilitate removal of undigested antibody from the neutralized reaction mixture by simple dialysis.

The authors are grateful to J. W. Williams for his continued interest in this work.

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A BIOTIN-LIKE SUBSTANCE PRODUCED BY DIPLODIA ZEAE

IN the course of studies of the physiology of the two species of the genus Diplodia which most commonly cause ear rots of corn it has become apparent that at least one important difference between them is the ability of *D. zeae* (Schw.) Lév. to produce in culture some substance, apparently found in many crop plants, which is necessary for the growth of both *D. zeae* and *D. macrospora* Earle. Margolin[1] has recently reported that *D. macrospora* requires "biotin or a biotin-like substance" for growth.

That this substance may be biotin is indicated by a number of similarities between it and the biotin obtained from egg yolks by Kögl and Tönnis.[2] A concentrate was obtained by the method of Buston and Pramanik[3] from a medium which contained KH_2PO_4 .3 g., $MgSO_4$ .25 g., KNO_3 2.0 g., dextrose 30.0 g., and distilled water to make 1 liter and which had been staled for 4 or 5 weeks by *D. zeae*. This concentrate is soluble in water and alcohol but is only very slightly or not at all soluble in ether, petroleum ether or chloro-

[1] M. L. Petermann and A. M. Pappenheimer, Jr., *Jour. Phys. Chem.*, 45: 1, 1941.

[2] P. Grabar, *Compt. rend. Acad. Sci.*, 207: 807, 1938.

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form. It is not inactivated by refluxing with acidulated methanol, but this process gives an active compound which is chloroform soluble. It is stable under treatment by hydrochloric acid and sodium hydroxide, is readily adsorbed by animal char and dialyzes readily through a collodion membrane. It is thermostable but is rendered completely inactive by nitrous acid.

A culture of *Saccharomyces cerevisiae* obtained from Dr. L. H. Leonian grew rapidly in the "B medium" used by Robbins and Schmidt[4] if a little of the staled medium was first added. Without the addition of the staled solution this "B solution" supported only a sparse development of the yeast.

It is known that vitamin H deficiency injury is induced in rats by a diet containing too much raw egg white.[5] A recent report states that raw egg albumen will also inactivate biotin *in vitro*. A test somewhat similar to that of Eakin, Snell and Williams[6] was applied to the staled medium. The white of a fresh egg and 10 ml of an aqueous solution of a concentrate of the staled medium were autoclaved for 20 minutes. The required aliquots of dextrose and minerals were then added and the solution re-autoclaved. Both *D. zeae* and *D. macrospora* grew well in this medium. Raw egg white added aseptically to a 500 ml of sterile medium containing 10 ml of staled solution completely inhibited growth of *D. macrospora* and markedly reduced growth by *D. zeae*.

These properties of the staled concentrate are very similar to many of those of vitamin H and coenzyme R which now are considered identical with biotin.[7, 8]

The details of the work on which the foregoing statements are based will be contained in a thesis submitted by the junior author.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFIED PHOTRONREFLECTOMETER FOR USE WITH TEST-TUBES[1]

THE substitution of test-tubes for refraction cells in photronreflectometric turbidity determinations has many desirable advantages, such as the simplification of technics, the elimination of the cost of the refraction cells and the availability of test-tubes.

One of the difficulties in adapting the use of test-tubes for photoelectric measurements has been the inherently poor optical qualities of the rounded sides of the tubes. This difficulty has been largely eliminated in the design of the "test-tube photronreflectometer," since a beam of light is directed up through the bottom of the test-tube instead of through the sides as in all conventional designs.

If an optically clear solution is placed in a test-tube and a beam of light is directed up through it the rounded bottom of the test-tube acts as a condensing lens and the light passes up through the solution. Since little or no light is reflected, the photronic cell, which is set at a 90° angle to the test-tube, is not activated and a zero reading is obtained on the galvanometer. If, however, a turbid solution is placed in the test-tube some of the light passing up through is reflected by the suspended particles and falls on the active surface of the photronic cell.

The amount of current generated by the photronic cell is dependent on the amount of light reaching it; this in turn is dependent on the number of particles in the suspension. This relationship holds over a range of turbidities—the lower limit of which is determined by the amount of light put through the system, the sensitivity of the photronic cell and the sensitivity of the recording galvanometer; the upper limit of which is determined by the factor of adsorption of light in too dense suspensions.

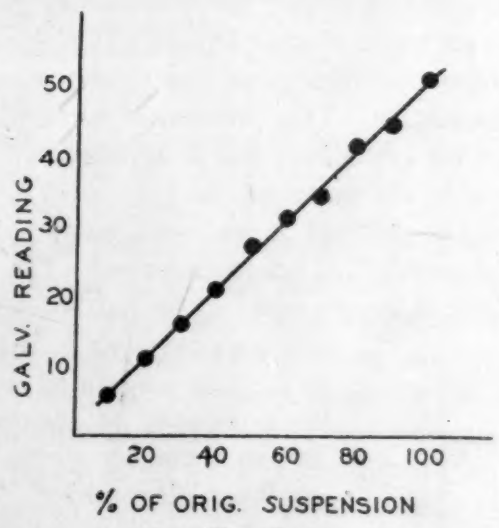

FIG. 1

Fig. 1 is a typical sample of a plot of galvanometer readings against known percentage dilutions of a bac-

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terial suspension. As indicated, a linear relationship is obtained between the galvanometer reading and the turbidity of the solution over a range of galvanometer readings from 10 to 60.

A 32 candlepower, 6-volt lamp furnished the light source. Current for the lamp was supplied by a constant current voltage regulator. A galvanometer with a sensitivity of 1 mm deflection per 0.125 microamperes was used to record the current generated by the photronic cell. Round bottom 100 × 13 mm soft glass or pyrex test-tubes were used to hold the turbid solutions.

In checking several hundred of the above test-tubes it was found that only 1 in 10 gave a deviation in reading of over ± 1.0 per cent. with a constant suspension.

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AN IMPROVED WATER BOTTLE FOR SMALL "CAGED" ANIMALS

INVESTIGATORS working with albino rats are constantly aware of the inefficiency of the various types of water bottles necessary for large stock cages. Containers which have an opening large enough for the animal to enter its head likewise serve as receptacles for excreta. An improvement over this type of container is the inverted bottle carrying a straight glass tube. Yet, it, too, offers disadvantages, since proper functioning depends on an equal pressure both inside and out. Thus, whenever from one third to one half of the contents are consumed, a vigorous regurgitation is initiated and continues until the container is empty. As a result of such action, the animals may go several hours without water or other liquids. The cages become and remain wet, which gives rise to obnoxious odors and contamination. This problem is particularly evident when the attendants find it impossible to keep a close check on the water bottles.

To meet the problem of inefficient water bottles for rats, an adaptable unit has been devised. The apparatus required is simple and can be put together from materials available in the laboratory. The apparatus used here has a capacity of approximately 500 cc, a number eleven stopper and 7 mm glass tubing. This improved container, schematically shown in Fig. 1, will not leak or regurgitate when properly adjusted. Tubes *C* and *D* should be of equal length when in place. This is best attained after the end *C* has been introduced through the stopper. Place the inside of the stopper along the straight edge of a laboratory table, thus permitting the ends of the tubes *C* and *D* to rest flat against the top surface of the table. Mark both tubes at an even length from the straight edge, cut and fire polish. Tube *A–B* should be a short close bend, and the length between the center of the bend to the end of *B* from 1 to 1½ inches.

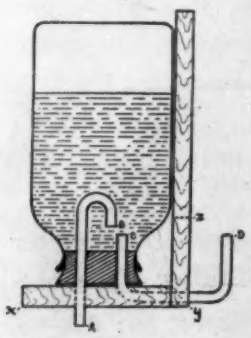

FIG. 1

Fill the bottle, put stopper in place and invert. Tube *A–B* will serve as an air inlet. By means of the inverted siphon *C–D* the water will flow through the tube without the aid of force. However, since *C* and *D* are at the same height the water will not flow beyond *D* without additional pressure. This pressure is supplied through the air inlet tube *A–B*, whenever the animal removes the slightest amount of water. The ideal distance between *B* and *C* is ½ inch. In the event that the contents flow too freely, the distance between *B* and *C* should be shortened. On the other hand, should the supply be insufficient the distance between *B* and *C* should be lengthened. The container can be attached to the side of the cage. However, the apparatus is conveniently handled when allowed to rest on a simple rack, as shown in Fig. 1. The rack can be made from two pieces of wood nailed at right angles, and permanently fastened to the side of the cage by screws or bolts. It is necessary to saw a block of wood one quarter inch wide from the center of the rack through *xyz* for the passage of the two tubes. This will allow the bottle to slide in place, thus permitting tube *D* to enter the cage.

Through evaporation, removal of water by the animals or changes in temperature, the equilibrium is maintained. The balance is most delicate and remains constant when properly adjusted.

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